JUN 16 1943

AGRICULTURAL ENGINEERING

JUNE 1943

Some Recent Engineering Developments in Forage Harvesting *F. W. Duffee*

How Electric Equipment Increases War-Time Food Production *Richard Boonstra*

Carburetor Characteristics and Fuel Saving in Farm Tractors *Schroeder and Clyde*

The Planning of Farms for Management of Runoff Water *Marion W. Clark*

Results of Tests of a Grain Bin of Plywood Construction *L. W. Neubauer*

THE JOURNAL OF THE AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

New Life for Your Land

While you push your land, your labor, and your machinery to the limit to grow more food and fiber for war needs, you can fortify your soil against its enemies at home—erosion and exhaustion of fertility. While there may not be enough fertilizer for all needs, you can guard the fertility already in your soil, make it more available for growing crops, and, if you plow under legumes, actually add more of the most precious plant food—nitrogen.

Nature herself uses vegetation to guard soil. Recognizing this, farmers in many regions already have found it good practice to keep vegetation of some kind on the land as nearly as possible throughout the year. Close growing vegetation shelters the soil from sheet erosion by absorbing the force of pelting rain that hits bare soil like miniature bombs.

Living or dead vegetation, when plowed under, adds valuable organic matter to the soil and helps hold it from washing and blowing. It also loosens heavy soils, firms those that are lighter, and increases water-holding capacity, thereby decreasing run-off. As organic matter decomposes in the soil, it furnishes plant food in a form readily available to crops.

Cover crops, planted to grow and occupy the land during the time between main crops, prevent the loss of fertility in drainage water. Nitrogen and certain mineral plant foods are constantly being made available, and unless absorbed by growing plants this fertility leaches or drains away. When the crop is plowed under as green manure, its plant foods go back into the soil, readily available for future crops. Legume cover crops have the added advantages of utilizing nitrogen from the air, and of more rapid decay after turning under, due to their higher moisture content.

Start now to fortify your land with more cover crops, using the drill or seeder, plow or disk harrow you now have. The amazing job of clean covering in a breast-high thicket of sweet clover, shown above, was done by a regular Case Centennial plow with all-purpose bottoms.

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CONTENTS FOR JUNE 1943

Vol. 24, No. 6

EDITORIAL 182

NEW DEVELOPMENTS IN FORAGE HARVESTING 183
By F. W. Duffee

REDUCING LABOR AND POWER IN RICE PRODUCTION 185
By H. T. Barr and H. A. Kramer

ELECTRIC EQUIPMENT FOR INCREASING FARM PRODUCTION 187
By Richard Boonstra

MOW CURING OF PARTLY CURED LONG HAY 188
By J. B. Stere

CASTOR BEAN HULLERS 189
By E. D. Gordon

CARBURETOR CHARACTERISTICS AND FUEL SAVING IN FARM TRACTORS 191
By E. W. Schroeder and A. W. Clyde

RUBBER FROM GUAYULE 194
By Harry F. Blaney

PLANNING FARMS FOR MANAGEMENT OF RUNOFF WATER 197
By Marion W. Clark

TESTS OF A PLYWOOD GRAIN BIN 199
By L. W. Neubauer

DEHYDRATION OF SWEET POTATOES FOR LIVESTOCK FEED 201
By Ray Crow

A.S.A.E. WAR SERVICE HONOR ROLL 204

NEWS SECTION 206

AGRICULTURAL ENGINEERING DIGEST 212

EDITORIAL

Pilots of Farm Production

ONE IMPORTANT fact, obvious to men close to agriculture, seems to have been overlooked in the statistical myopia of our national planning. Farming is not a game which can be played as well by a visiting team as on the home grounds. Nor can it be played so well by amateurs and rookies as by seasoned professionals.

To the soldier or the statistician, a farm hand is just a farm hand. To the cow a farm hand is either her old and trusted friend, or a stranger from whom she withholds some measure of her milk. Neither horse nor mule will do so well with a stranger at the reins, nor will hens cackle the aftermath of ovulation so freely in the care of alien attendants.

Only the man who knows his farm as a pilot knows the shoals and channels of his own harbor can tell where to slow the tractor and raise the plow to skim over rock or root. The more mechanized, and hence the more productive, a farm may be, the more it needs not only skill in general, but familiarity with its own features and equipment. Even at this late date, recognition of these facts in manpower policies will help to minimize the imminent shrinkage in food production.

By Metes and Bounds

PUBLICATION in this issue of the paper by Marion W. Clark, on planning farms for water management, comes at the same time as announcement of an incident which we believe is destined to be a milestone not only in water management but in good-neighboring among farmers.

In a broadcast over W L S, Arthur Page of "Prairie Farmer" told of two farmers who rearranged their farm boundaries and line fences for fuller conformity and more convenient operation with the practice of contour farming. He did not go into technical detail, but mentioned that they had taken legal steps to wipe out the traditional description by section and fraction thereof, and to adopt for all purposes of taxation, devise, etc., a new description of new boundaries based on contours.

Mr. Page saw in this an example to nations in making adjustments for peace based on mutual recognition and compromise of national needs. As agricultural engineers we have no need to expand the example so broadly. It will be momentous to American farming if we do no more than erase the rectangular concept of land tenure and replace it with one of farming units laid out along contour lines. No longer need the line fence cut like a cleaver through the profile of terrace and flowage way.

Presumably most farmers will prefer to follow the principle of give-and-take, so that each will be left with about the same acreage, value, and productivity of land as he had under the old boundaries. But there will be some sale and purchase of odd corners, some shrinkage and expansion to suit farm size to fit topographic features. There will be need not only for wise planning and accurate surveying, but for appraisals based not only on present values but on potential productivity and operating economy.

Farms will be less motley mixtures of upland and lowland, less diverse in soil type and crop adaptation. There can be less duplication and diversity of equipment, permitting more complete mechanization with less investment. Fencing practice no doubt will be modified, and even the farmstead buildings may be remodeled or possibly relocated.

Once this contour concept is accepted, not only the line fence but the rural road is put on trial. Why should it follow an imaginary line in the heaven above and ignore the earth beneath? Let it, too, be relocated to serve not only rolling wheels but running water, its own drainage integrated with that of adjacent farms. It well may be that we shall be glad to find not improved roads but unimproved roads.

Like the prophet Mahomet, farmer and engineer can go to the mountain for guidance. It will give us precedent for descriptions by metes and bounds, a pattern for fields and fences fitted to soils and slopes, a respect for man's relation to his environment.

Bread and Circuses

CURRENT controversy over cost of living, wages and prices, purchasing power and inflation, and particularly the rollback and its accompanying subsidy, all cut into the philosophy and practice of agricultural engineering too deeply to be ignored.

From the standpoint of economic theory alone, there is something to be said for the subsidy. To the rather considerable extent that distribution costs, the so-called middleman's charges, are determined by pyramided percentages, it would seem possible to cut consumer prices by subsidy at point of origin. If a Colorado farmer now gets one cent for a head of lettuce and it sells in New York for 30 cents, raising the farm price to two cents would prorate the city price to 60 cents. But leaving the farm price at the low figure and subsidizing the farmer by the second cent would (theoretically) hold the city market price at 30 cents and make the total cost only 31 cents, a social saving by subsidy of 29 cents.

Actually, of course, the saving would be far less, both because some charges, notably transportation, are merely additive, and because agents of distribution encounter real rises in costs, just as does the agent of production, the farmer. Such real savings as would remain, we think, would cost too much.

As agricultural engineers, our job is to multiply the production of food per hour of labor, permitting the producer to be paid more and the consumer to pay less. As those who actually accomplish this, we deplore the political make-believe which seeks to simulate these ends by plundering the public treasury. It is not intellectually honest, not socially sound, not economically expedient.

For too long, food was too cheap. As a nation we fostered the fallacy that food should be too cheap. With so-called surplus commodities and lavish relief, WPA and whatnot, we forced agriculture to bear the brunt of the psychological burden while we administered a merely symptomatic treatment to an ailing purchasing power among urban customers. Now it is proposed, in the guise of a war measure, to prolong the pauperization of the proletariat. Whether or not so recognized by its proponents, it is the history of the old Roman bread and circuses being repeated.

If the political powers are actually alarmed about the excess of purchasing power over availability of consumer goods, they can find no better way to absorb some of the excess than to let people pay for their food what it costs to provide. It may require more *(Continued on page 214)*

AGRICULTURAL ENGINEERING

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New Developments in Forage Harvesting

By F. W. Duffee

FELLOW A.S.A.E.

THE HARVESTING and storing of forage covers a vast field of research, and agricultural engineering is involved in practically all of its phases. The term "forage" includes all the hay crops put up either as grass silage or dry hay, straw left by the combine, and corn silage. This paper, however, deals primarily with the silage phase.

The harvesting operations alone include a large number of equipment developments, the principal ones being the field forage harvester, the blower at the silo or barn, suitable wagon boxes, and new forks. In addition, we included in our research work at the University of Wisconsin this past year (1942), the following developments: (1) A corn meal attachment to apply corn meal or other similar preservatives to grass silage, (2) the design of a new elbow for the top of the blower pipe, (3) the application of the combine engine to the blower, (4) the use of the V belt and adjustable V-belt pulleys as the drive for the blower, and (5) the use of quick-acting ball-and-socket hitches for the wagons and equipment. We believe most of these items must be properly developed and correlated with one another in order to have an efficient organization of equipment and man power to handle the work of putting up silage.

The main objectives in our research work were to: (1) observe especially the performance of the forage harvester; (2) observe the performance of the University of Wisconsin and commercial make of crop blower; (3) observe the performance of the corn meal attachment; (4) study and observe the correlation and balance of the entire equipment, and (5) arrive at costs of putting up grass silage and corn silage by this method.

The following equipment was assembled for our research project: (1) The forage harvester with 40-in cutter bar for grass silage and with a one-row attachment for cutting corn silage; (2) a full two-plow, tricycle type tractor pulling the forage harvester; (3) a full two-plow standard type tractor used for hauling; (4) three rubber-tired farm trucks equipped with specially designed beds; (5) a commercial make of experimental blower; (6) the University of Wisconsin experimental blower; (7) two 23-hp power units as used on a popular make of small combine; (8) combine main drive V belts and adjustable V pulleys with special hubs having straight bores; (9) three new model grass silage and chopped hay forks; (10) quick acting ball-and-socket hitches on all the equipment; (11) an experimental corn meal attachment; (12) a pitless wagon scales, and (13) the experimental blower pipe elbow. All equipment was on rubber tires and the list of equipment was complete in every respect, so that when we went on to a farm we had everything to do the job.

A crew of four men was furnished with the equipment, consisting of a record keeper, a company engineer, and drivers for the two tractors. Additional help needed consisted of three or four men, one to load, one or two to unload, and one in the silo.

The equipment was used in cutting 973 tons of grass silage and 305 tons of corn silage, a total of nearly 1300 tons. Of the grass silage 753 tons were cut for eight farmers on a custom basis; the balance of the grass silage (220 tons) and the corn silage was cut on the University farms. All the loads except about 175 tons of grass silage were weighed and a large percentage were accurately timed for loading, unloading, changing wagons, and hauling.

The Forage Harvester. The functional performance was quite satisfactory. Some structural weaknesses were found, most of which were corrected before the season was over. The power required to operate the machine is, in our opinion, excessive. We believe it should handle at least 50 per cent more material with the same or less power. Basic research is needed in the design of the cutting heads of all forage harvesters.

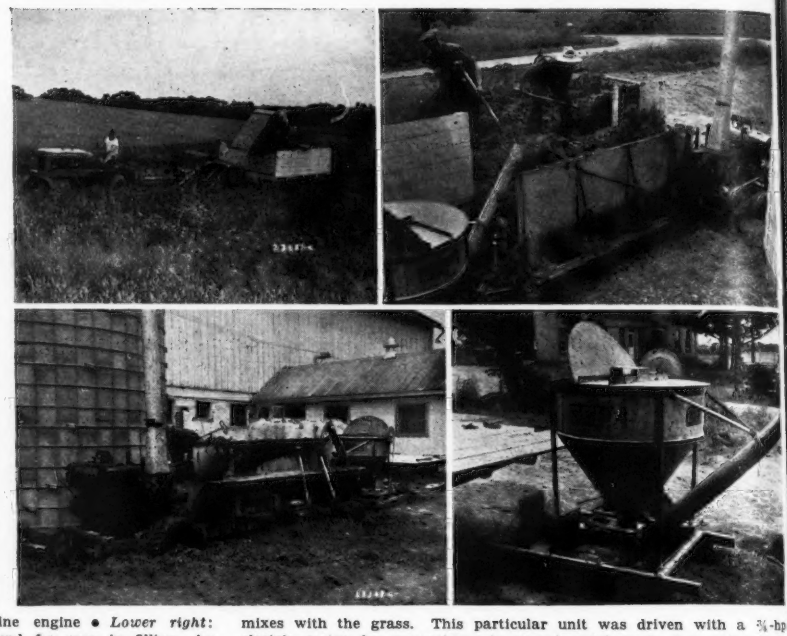
Pulling the wagon behind the harvester is most satisfactory, but with this machine and at least some others considerable side draft is encountered, enough at times to be troublesome.

The corn attachment operated remarkably well, but the product was somewhat unsatisfactory. While much of the material is cut very fine, nevertheless some long shredded pieces of stalks go through the machine and husks and leaves are not cut as finely as is desired. In one case the cattle are refusing about 6 per cent of the total corn silage fed. The nature of the cut apparently reduced the capacity of the silo, particularly in the case of well-matured silage which was not frosted.

The Crop Blowers. The University of Wisconsin experimental blower gave excellent performance in every respect, indicating that

Paper presented December 9, 1942, at the fall meeting of the American Society of Agricultural Engineering at Chicago, Ill. Author: Chairman, agricultural engineering department, University of Wisconsin.

Left: This equipment put up 973 tons of grass silage from June 6 to July 16, 1942, and 305 tons of corn silage in the fall. The blower pipe, wagon scales, and meal attachment were hauled in the wagons • *Right:* This shows the forage harvester with the corn attachment in place and operating. The machine handled a very heavy crop quite satisfactorily. The principal objection was the quality of the cut



Upper left: The forage harvester in action in a heavy crop of alfalfa and brome grass. The machine has a 40-in cut and for the most part gave reasonably satisfactory service • *Upper right*: This shows advantages and convenience of unloading from the side of the large wagon rack. The wagon box is 7 ft 11 in by 14 ft outside by approximately 3 ft deep. The side door open as shown here is 7 ft wide. The wagon will hold up to slightly over 3 tons of green material. Two men can unload without interfering with one another. Material in the most remote corners of the box can be pitched easily into the blower feed table. The V-belt drive gave extremely satisfactory performance throughout the season. The V pulleys with hubs bored for straight shafts will be in limited production during 1943 • *Lower left*: This is the University of Wisconsin experimental blower with combine engine mounted directly on blower frame and corn-meal attachment at the outer end of feed table. Note the new model forks, 19 in wide with tines 19 in long. The most convenient way of filling; the corn-meal attachment is to back the load of meal up to the attachment as shown. This blower gave very satisfactory performance under any and all conditions for both grass silage and corn silage. Limited trials with chopped dry hay indicates that with minor adjustments it would be satisfactory for this material. It had a maximum capacity on 45 to 50-ft silos of slightly over 24 tons per hour when operated by this small combine engine • *Lower right*: The corn-meal attachment sits on the ground for ease in filling. An auger elevates the meal into the feed table of the blower where it mixes with the grass. This particular unit was driven with a ¾-hp electric motor for convenience in experimental work, but under ordinary conditions the unit should be driven from the blower

the principles of design incorporated in this machine are sound. They are as follows:

1 The feed table laid out at right angles to the blower shaft, so that the load may be driven alongside the feed table for unloading, similar to unloading at a threshing machine.

2 A positive feed table mechanism, in this case a 14-in square pitch auger operating in a 16-in trough. The feed table is about 7 ft long.

3 A leveling device to level off large bunches of material resulting from uneven feeding.

4 A combing device that feeds material into the fan in an even stream distributed as uniformly as possible through the air stream.

The power requirements seemed to be very satisfactory as a 23-hp engine successfully elevated grass silage up to 24 tons per hour into a 50-ft silo and corn silage equally well into a 40-ft silo.

The blower was tried on a very limited scale with chopped dry hay. Apparently all that is needed is to be able to raise the leveling device higher than was possible on this particular machine.

The commercial blower gave fair results. It uses a conveyor feed table similar to ensilage cutters. Such a conveyor is not positive in feed, with the result that the leveler rolls the material back off the table and actually allows less material to enter the fan than when the machine is fed just up to the capacity permitted by the leveler. No combing device was present, thus material entered the fan in slugs or bunches which could be observed at the discharge of the distributor pipe in the silo.

The Blower Type Elbow. An elbow was designed and built having a cubic parabola curve ($y=x^3$) in order to overcome clogging troubles encountered in conventional elbows which are segments of circles. (Values of x from 0 to 1.4 or 1.5 should be used; the value $x=1.5$ provides a better curve, but the elbow becomes rather long.) This elbow was used throughout the season, and while definite data are not available regarding its performance, observations indicate that it does overcome the troubles of the conventional type.

TABLE 1. REPORT ON CROP BLOWER PERFORMANCE

Date	Name of blower	Crop	Fan rpm	Total no. loads*	No. loads here recorded†	Avg. tons per hour
June 8	Commercial	Alfalfa	975	30	20	13.22
June 24	Commercial	Sweet clover	975	9	7	15.43
June 18	Univ. of Wis.	Alfalfa	865	28	20	17.78
July 11	Univ. of Wis.	Alfalfa	975	21	11	18.14
July 13	Univ. of Wis.	Alfalfa	975	8	5	17.22
July 14	Univ. of Wis.	Alfalfa	975	12	6	17.02

*Total loads for the day or half-day are shown in this column.

†In selecting the loads for making up the above table, only those were used which showed an unloading rate above 16 tons per hour for the University of Wisconsin blower and 12 tons per hour for the commercial blower.

MAXIMUM RATES OF UNLOADING (1 load per test)

6-8-42 Commercial blower—975 rpm—Alfalfa—15.075 tons per hour
6-24-42 Commercial blower—975 rpm—Sweet Clover—16.275 tons per hour
6-18-42 University of Wisconsin blower—865 rpm—Alfalfa—24.375 tons per hour
7-11-42 University of Wisconsin blower—975 rpm—Alfalfa—24.475 tons per hour

The Corn-Meal Attachment. The hopper holds about 500 lb of meal or enough for a load of two to three tons. It is set on the ground for ease in filling and has a 5-in auger to lift the material to the feed table of the blower. The design of the agitator is important to prevent clogging and wrapping with husks in the case of corn and cob meal.

Combine Engine and V Belt Drive. Thousands of combines now in use are equipped with auxiliary engines. These engines will develop from 15 to 30 hp and can be used very satisfactorily for all kinds of belt work, such as operating the feed grinder, the ensilage cutter, the blower for grass silage or corn silage where the field harvester is used, and the other odd jobs such as sawing wood or shelling corn.

Both of the blowers were equipped with engines and V-belt drives. The arrangement was most satisfactory in every respect, and especially convenient for setting up. The 23-hp engines provided ample power at all times.

The Hitches. All of the equipment was provided with good but reasonably cheap ball-and-socket hitches, for safety and speed in hitching up and unhitching. The driver of the hauling tractor became proficient in hitching up and unhitching without getting off the tractor by using a rod with a hook on the end to lift the tongue into place and close or open the hitch. The average time for changing wagons on the forage harvester was 1.44 min when everything was operating smoothly. We believe now that a modified hitch of the Holland type, as used on plows, would be more satisfactory as it is more rugged and easier hitched up and unhitched.

The Grass Silage Wagon Boxes. These boxes, while designed primarily for field-cut silage, hay, or *(Continued on page 186)*

Reducing Labor and Power in Rice Production

By H. T. Barr and H. A. Kramer
MEMBER A.S.A.E.

THE TREMENDOUSLY increased demand for labor in the war industries emphasizes the need for increased efficiency in the use of labor and power in the production of rice. The importance of this is appreciated when we consider that in 1941 the United States produced 1,245,000 acres of rice with a total yield of over 54 million bushels, and that in general the labor and power required to produce an acre of rice is considerably greaater than for any of the other small grains commonly grown.

To continue the production of equal or greater quantities of rice with reduced power and labor will require the adoption of more efficient methods and practices such as those briefly presented in this paper.

Distribute Peak Labor Period by Growing Early, Medium, and Late Varieties of Rice Over a Wider Range of Growing Season. The soil and climatic conditions that prevail over the majority of the rice areas are such that there can be considerable elasticity in the planting date and in the variety of rice grown.

Data obtained by the Louisiana Rice Experiment Station at Crowley on the effect of date of seeding on the length of growing period of rice are shown by the following table:

Variety	Average date of maturity when seeded	
	March 1	June 1
Early Prolific	July 12	October 1
Fortuna	August 7	October 21
Blue Rose	August 21	October 14
Rexora	August 29	November 5

This data indicates that with proper consideration given to planting dates, labor and power requirements need not be excessively great during any particular period of the growing season.

Work Maximum Acreage Which Present Equipment Will Handle. To obtain maximum efficiency a machine must be operated at somewhat near its rated capacity. Where possible, the use of combinations of implements performing several operations at one trip over the field will reduce man labor and power in relation to the work performed. Most farmers with a little ingenuity in the development of hitches can make combinations out of the implements they now own and operate.

In many instances cooperative use of farm machinery may be desirable. This is especially true with special types of implements such as drills, binders, etc., which are used for only one operation in the production of a rice crop. Cooperative use of such machinery would add greatly to their machine hours use per year and as a result increase their total production per machine unit.

Every farmer owes it to himself and to his country to work the maximum acreage that his equipment is capable of handling. When the capacity of his equipment is greater than his acreage, he should either rent additional acreage, or in the event such acreage is not available he should do custom work.

Improve Levee Construction Methods. Many machinery breakdowns resulting in loss of valuable time during the busy season and requiring repairs almost impossible to get would undoubtedly be prevented by using greater care in the construction of the many levees required in a rice field.

A levee with perhaps a little broader baseand more rounded finish could be built with little added effort. Such a levee could be crossed with rice harvesting equipment without the violent twisting and bending action ordinarily experienced.

Improvements can often be made in the location of the levees themselves. A carefully surveyed system of levees will permit the most efficient use of the water and a more uniform depth of submergence, thereby reducing to a minimum the unproductive grassy areas not properly covered by water.

Increased Use of Binders, Combines, and Dryers. In some rice-producing areas, especially where sugar cane is the predominating crop and rice is the supplementary crop, there has long existed an abundance of cheap labor. As a result much of the rice in these areas is still produced using hand labor entirely except for the actual threshing operation.

During the past season the cost of such hand labor has increased until it is no longer economical to produce rice by that means. The use of rice binders in such areas would be desirable from the standpoint of reduced harvesting costs and would release labor for use in other areas and other activities where greater shortages exist.

The rice combine and rice dryer have proven very satisfactory in reducing labor and power requirements by reducing the number of operations and machines required. With such equipment a crew of four men can easily harvest as much rice per day as a crew of twenty men using binders and threshing machines.

During the past season combines were observed operating successfully in fields flooded to a depth of one foot by heavy rains and poor drainage. Such conditions could easily have resulted in the total loss of a valuable crop if binders only had been available for harvesting.

Windrowing machines followed by combines with pickup attachments have been used successfully in some areas. These machines have greatly simplified the harvesting operation and are particularly valuable in areas where rice dryers are not available.

Combine-replaced harvesting machinery should be diverted to areas where this equipment is needed and used to replace similar equipment which has become worn out.

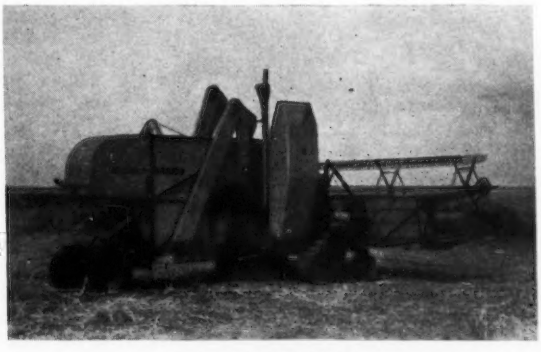
Bulk Handling and Storage of Rice. The war effort with its increased demands on transportation facilities and materials has brought about a shortage in burlap ordinarily used in great quantities to make sacks for rough rice. This added problem to the rice-producing areas can best be met by the adoption of bulk-handling facilities.

The use of a small elevated self-cleaning bin of about a truck load capacity which can be moved from place to place with the rice threshing machine, will eliminate the need for labor to fill, sew, and load sacks of rough rice. With such a bin a truck can be backed underneath and filled by gravity. Where two or more trucks are available the bin itself often can be eliminated and the trucks loaded by gravity directly from the threshing machine.

After being loaded the bulk rice can easily be moved to mills equipped to handle bulk rice or, if more desirable, placed in bulk storage.

Throughout the rice areas there are many sack storage warehouses which can be converted to bulk storage with a minimum of new materials by the addition of a few partitions to form bins and a few conveyors for moving the bulk rice about.

Where sufficient new material can be secured the construction of new bulk storage is recommended. In this case construction should be carried out so that rice-drying facilities can be easily added at a later date.



A rice combined harvester-thresher

Paper presented at the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1942. Authors: Respectively, Head, agricultural engineering research and agricultural engineer, Louisiana Agricultural Experiment Station.

Recently the Commodity Credit Corporation offered the rice growers a small prefabricated bin of about 1600-bu capacity that can be adapted to bulk rice. These bins are available at a cost of approximately 15c per bu capacity and are receiving favorable comment throughout most of the rice areas.

Increased Yields. One of the most important factors in increasing rice production in relation to labor and power is large yields. Other than the cost of harvesting, the labor and power requirements for producing a crop are the same for small yields as for large yields.

Increased yields may be brought about by more extensive use of fertilizers where available, and by utilizing to the fullest extent the most fertile areas adapted to the production of rice.

A crop rotation embodying legume crops, meadows, pastures, and livestock with rice will increase yields.

Improved seed of adapted varieties free from red rice, noxious weed seeds, and other foreign materials will materially aid in producing a higher quality rice crop and more fully accomplish the agricultural engineer's objective, namely, securing maximum production with a minimum of labor and power.

New Developments in Forage Harvesting

(Continued from page 184)

straw, nevertheless are very satisfactory for other uses. The platform is a standard type flat bottom 7 ft 11 in x 14 ft, which can be equipped with uprights, thus forming a conventional hay rack, or it can be equipped with sideboards of any height. As used for grass silage, the boxes are 7 ft 8 in x 3 ft deep, and for use with a blower of the type referred to above, double doors 7 ft wide are cut in to each side for convenience in unloading. The general design is simple and rugged.

The Forks. The ordinary pitchfork is entirely unsatisfactory for handling this material. The ordinary straw or barley fork is also too small, and the conventional silage fork had too many tines. The forks we used are a new design. They have eight slender tines, and the fork is 19 in wide and 19 in long with D handles. They were accepted favorably in all cases.

The Scales. In order to secure accurate data, all loads had to be weighed. A pitless type of wagon sides was arranged so that it could be quickly and easily "knocked down" for moving.

Combination of Equipment. The custom work phase of the project shows what can be done in the way of getting a lot of work done on several farms with a single set of carefully coordinated equipment, which plan may be very important in wartime with impending shortages of equipment. The efficiency of this particular set of equipment is illustrated by the fact that we cut nearly 1,000 tons of grass silage and 300 tons of corn silage, which I believe could be increased easily to 500 tons of corn silage with additional substantial tonnages of dry hay and straw. In one case the blower and scales were taken down, moved about ½ mile, set up, and were in operation again in 1 hr and 17 min.

SUMMARY OF PERFORMANCE

Grass Silage

Average loading time, cutting only (does not include any time except cutting)	6.78	tons per hr
Average over-all loading time (average for all time at work)	5.715	" " "
Average unloading time (unloading only)	12.47	" " "
Average fuel consumption:		
Cutting	0.396	gal per ton
Unloading	0.154	" " "
Hauling	0.1415	" " "
Man labor (based on a crew of six	1.05	man-hour per ton
Man labor (based on a crew of five)	0.88	" " " "

Best Performance for a Day or Half-Day

Crop — Alfalfa

July 15—Biggest day	55.857	tons
July 11—Average loading time (cutting only)	8.62	tons per hr.
July 11 — 46 tons in 7⅓ hr (long haul, some waiting in field for wagons)	6.30	" " "

Crop — Sweet Clover

June 24—Average loading time (Cutting only)	8.92	tons per hr
June 24 — 22 tons in 3 1/5 hr	6.88	" " "
Average weight of all loads	1.815	tons

Corn Silage

Average loading time (cutting only)	8.695	tons per hr
Average over-all loading time	6.95	" " "
Average unloading time (unloading only)	15.57	" " "
Average fuel consumption:		
Cutting	0.397	gals per ton
Unloading	0.144	" " "
Man labor (based on crew of 6)	0.865	man hours per ton
Man labor (based on crew of 5)	0.720	" " " "

Best Performance

Sept. 16—Best day	68.202	tons
Sept. 16—Average loading time (cutting only)	10.230	tons per hr
Sept. 16—Average over-all loading time (7 hr 51 min)	8.71	" " "
Average weight of all loads	1.882	tons per hr

CONCLUSIONS

1 It has been demonstrated that the machine will do the following: (a) Cut grass silage, (b) chop dry hay, (c) chop straw left by the combine, and (d) cut corn silage.

2 The new machinery should cost less than the machinery it displaces. It should replace the hay loader, the hay fork, and the ensilage cutter, and on many farms the corn binder.

3 Cost of putting up grass silage is cut in two:

Method	COST PER TON Labor at 25c per hr	Labor at 40c per hr
Harvester method	$0.662 to $0.817	$0.82 to $0.97
Ensilage cutter method*	$1.59	$1.93

*Ohio Mimeograph Circular No. 127

4 Labor of putting up grass silage reduced over one-half, and much easier work:

Harvester method (6 man crew)	1.05	man-hours per ton
Harvester method (5 man crew)	0.88	" " " "
Ensilage cutter method	2.3	" " " "

5 Cost of putting up corn silage approximately cut in half:

Method	COST PER TON Labor at 25c per hr	Labor at 40c per hr
Harvester method	$0.544 to $0.671	$0.674 to $0.80
Ensilage cutter method*	$1.14	$1.41

*Farmers' Bulletin 1725 (pp. 7 and 13)

Wisconsin Circular No. 386 shows a cost of $1.84 per ton exclusive of the silo cost.

6 Labor in putting up corn silage reduced about one-half:

Harvester method (6-man crew)	0.865	man-hours per ton
Harvester method (5-man crew)	0.720	" " " "
Ensilage cutter method	1.49	" " " "

(Farmers Bulletin 1725, pp. 7 and 13)

7 It is estimated that a crew of two can put up grass silage at a rate of 20 to 25 tons per day.

8 Probably the most outstanding single fact gleaned from this year's experience is that out of thirty-four consecutive work days, we put up some grass silage on 33 days. The season was unusually rainy — at least it rained on more than the usual number of days, but we were rained out completely on only one work day. Grass silage then is a very fine method of saving the hay crop.

Electric Equipment for Increasing Farm Production

By Richard Boonstra
MEMBER A.S.A.E.

THE NEED for critical materials to prosecute the war has meant that electrical equipment available for use on the farm has had to be curtailed. It is therefore vital to farmers who have electric service that they know more about the part electricity can play in increasing food production.

Our specific problem then is that of getting the maximum use from electric equipment to help increase farm production. For convenience I will divide the electric equipment to be discussed in this paper into two classes, namely, (1) that built by manufacturers and (2) homemade equipment.

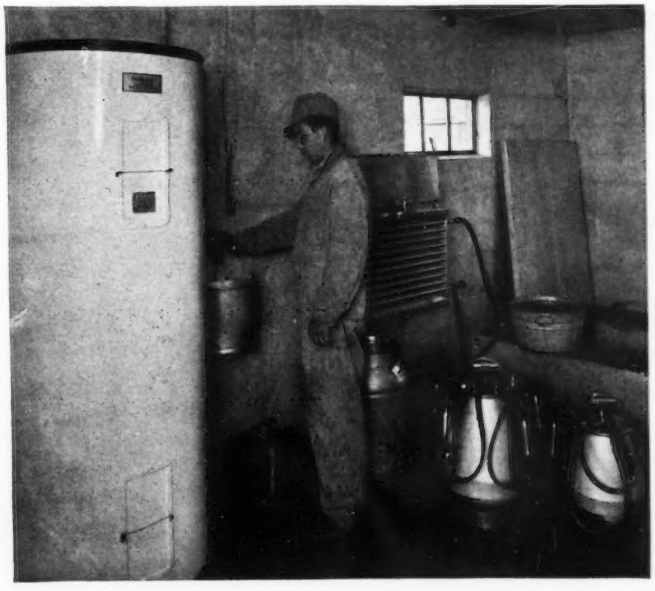
Under the first classification comes such items as the electric light bulb, water pump, milking machine, dairy water heater, feed grinder, the chick brooder, and electric motors up to and including 5-hp portable motors.

The wiring system on the farm really serves as the foundation for the operation of electrical equipment and fortunate is the farmer who today has an adequately wired farm. Adequate lighting around and in farm buildings improves farm safety by avoiding dark spaces thus helping to avoid accidents. Today, in many instances, the farmer and his wife must work alone in an effort to increase production. Labor everywhere is scarce and precious; lighting for safety then means lighting for production.

Extensive tests by a number of experiment stations have proven that proper electric lighting in the hen house stimulates egg production from 10 to 20 per cent. The U. S. Department of Agriculture set a national quota for 1942 of 7,250 dozen eggs every minute of the year. Just 10 per cent increase would represent 725 dozen eggs each minute — a sizable job for electric service even if all poultry farmers or those having small flocks were electrified, which they are not. This places that much more of a burden upon those who have service. Lighting was the first electric application for increasing production on the farm and has always paid its way.

The automatic electric water pump may, in my opinion, be rightfully considered as the principal key to increasing farm production of milk, beef, pork, poultry, and eggs.

Michigan State College tests showed a dairy cow drank 3.4 lb of water for every pound of milk produced. Iowa State College made an interesting test on the consumption of water by milk cows using individual drinking cups. The results showed an increase of 18 per cent in milk production and 6 per cent increase in butterfat. This was undobtedly due to the fact that fresh palatable water was available to the cows at all times. Under the present wartime conditions if farmers are not able to purchase inside drinking cups, it would appear practicable for them to build small watering tanks of lumber and place them inside the dairy barn. Increases of even 10 per cent in milk from the same herd means a great deal for the war effort.



Paper presented December 8, 1942, at the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill. A contribution of the Rural Electric Division. Author: Agricultural engineer (manager of rural sales), Public Service Company of Northern Illinois.

Fresh water and plenty of it is not very practical by hand pumping and the cost of pumping water with electricity is very small. tests conducted at six demonstration farms in Illinois over a four-month period show that all the water pumped for 34 people, 183 dairy cows, 43 other cattle, 80 hogs, 1200 chickens, and 25 horses required only 820 kw-hr of electricity. During this four-month period the dairy herds from those six farms produced 7,560 cans of milk. Also, please bear in mind that this energy includes the water pumped to cool the milk from 98 F (degrees Fahrenheit) down to well-water temperature which usually varies from 55 to 60 F.

Assuming that the increase in milk production produced under Iowa State College tests were applied, we have some 1,360 extra cans of milk from six dairy farms in four months. Without the automatic water system the production of milk would undoubtedly have been substantially lower even though it might not be 18 per cent less.

Getting the maximum amount of milk from the dairy herd is a job that requires constant attention 365 days in the year. The various breeds of dairy cows are so highly bred that it takes an experienced animal husbandry man to care for them, and for that reason one or two men using a milking machine to do the milking will get the maximum amount of milk from the herd. Milking machines are quiet, clean, and efficient.

The job of milking is always thought of as something that must be done. If the family is in a hurry to go away, or is tired at night, the cows don't get milked quite the same as they are in the morning when everyone is fresh on the job; but the milking machine is always the same individual, is never in a hurry, and does the work (by actual test) in a little less than one-half the time it takes to do the milking by hand. Also, the machine will get some 12 per cent more milk according to Iowa State College Bulletin No. 248. The machine uses very little electrical energy. Actual tests on the six demonstration farms previously mentioned show that the milking machines used 1,048 kw-hr to milk 183 cows for four months, twice every day.

I am mindful of the fact that there are a number of small electrically operated feed mills on farms throughout the country and are doing a great job, in spite of the fact that farmers refer to them as coffee grinders. Just how much such equipment contributes to the increase of beef and pork, I am not prepared to say; but we know that beef and pork raisers grinding feed (medium fine) with 1, 3, and 5-hp mills are very well satisfied with the results they are getting.

On the farm in particular a 1-hp feed grinder ground an average of 13,000 lb of shelled corn, oats, and soybeans per month for 35 dairy cows, 18 young heifers and calves, 200 hogs, 50 sheep, and 250 chickens and ducks, using only 56 kw-hr to do this work. There are quite a number of such mills operating on Middle West farms.

The electric chick brooder is a labor saver and a chick saver at the same time as it is automatic in operation. Ordinarily

we think only of brooding chicks, but the electric brooder is used extensively in the raising of turkeys and ducks. A number of tests show that it takes an average of 1 kw-hr to raise a chick through the brooding period.

It is one thing to have good factory-made equipment to work with on the farm, but when a farmer goes to the trouble making his own equipment, or his boys make it, then you may be assured that his livestock is getting personal attention, which after all is what spells success on the farm — and *food for freedom.*

Under the classification of "homemade equipment" we are beginning to open up a field that during this present emergency will be of great help in increasing production through saving farm produce and livestock.

In Kankakee County, Illinois, four high schools made a total of 113 pig brooders in their vocational agriculture classes during January and February of this year (1942). One farmer in that county installed 32 homemade pig brooders.

The electric pig brooder is inexpensive to make on the farm and its use ordinarily saves from one to three pigs in every litter. It keeps them comfortable and away from the sow, except when they are nursing, for the first couple of hours of their life; it is during this period that the highest mortality occurs.

In our territory in northern Illinois we have recorded some 500 pig brooder installations. Practically all of them were made by 4 H Club boys and other farm boys in vocational agriculture schools; we supplied the plans and the light bulbs. Some of these schools are also planning to make chick brooders from plans prepared by the University of Illinois.

We recently built a device for stirring milk to cool it from 98 F to well-water temperature, the stirrer operating with a ¼-hp motor. This is a real labor saver as this device can stir from two to eight cans of milk at one time. Officers of the Kankakee Pure Milk Association were so well pleased with this stirrer for cooling milk that they requested 1000 sets of plans which they mailed to their farm customers. Three high schools have already requested use of the original model to build it in their classes.

Mow Curing of Partly Cured Hay

By J. B. Stere
MEMBER A.S.A.E.

THIS REPORT deals with three seasons experience on the dairy farm of Rogelle Leete, in north central Pennsylvania with mow curing of partially field-cured long hay. False floors with ¾ to 1-in cracks between the boards, were placed on top of each of three 20 x 40 tightly constructed mow floors. Each was so constructed as to distribute the air uniformly throughout the floor area while the cracks between the boards permitted the air to enter the hay from only the bottom of the mow. A propeller type fan, directly driven by a 3-hp motor and so mounted that it can be readily moved from one mow to another, provides 26 cfm for each square foot of mow floor area.

A crew of three men, two tractors, and one team harvest 80 acres of alfalfa, timothy, and clover for silage and mow hay. This crew also takes care of all the dairy activities. Consequently, from four to six weeks are required to harvest this forage crop. The small hilly fields which are of rough topography distantly located from the barn are factors which influence the harvesting practice of this farm.

Usually the early cuttings are chopped for silage and the more mature or later cuttings are stored in the mow, as weather permits. In either case, hay cut in the forenoon is stored in the afternoon of the same day or by noon of the next day.

Samples of the hay, as placed in the mow, showed a variation of from 20 to 50 per cent water content. Early cuttings placed in the mow seldom exceeded 30 per cent. As a mow was being filled, the fan would be operated during periods when atmospheric relative humidity was 60 per cent or less. A period of as much as two weeks has elapsed before a mow was filled to the capacity height of 24 ft.

Paper presented December 9, 1942, at the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill. A contribution of the Rural Electric Division. Author: Agricultural engineer, West Penn Power Co.

If at any one time the temperature in the mow increased to a critical point, the fan was started regardless of atmospheric humidity. The first year the temperatures in the mow were never permitted to exceed 110 F. Last year on one occasion the temperature inadvertently was allowed to reach 140 F before the fan was started.

This farmer has expressed satisfaction with the performance of the system. Influencing factors perhaps are (1) that about five years ago he lost a barn by fire, presumably caused by spontaneous combustion; (2) limited man-hours that can be devoted to harvesting; (3) character of the terrain and long hauls, and (4) improved quality of hay.

Following are some observations of the performance of this installation:

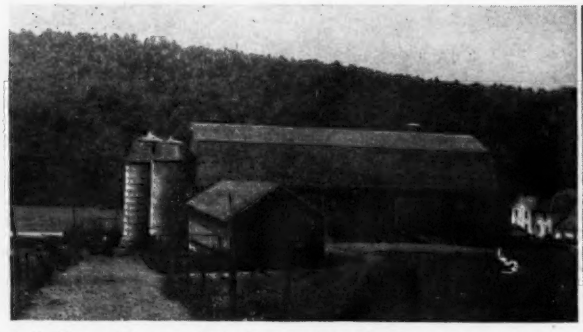
1 Forced ventilation will cool mowed long hay. Under favorable conditions, the temperature in the mow can be reduced to lower than atmospheric temperature. This indicates some evaporation.

2 The fire hazard is reduced, remembering, of course, that the amount of succulent material present in the hay has a great influence on drying.

3 Because storage was possible without undue bleaching, loss of leaves, or excessive mow heating, it is fair to assume that higher quality hay can be obtained with this system. The farmer claims higher quality on the freeness of dust as the hay is being fed off and the fact that the cattle consume more.

4 The average electrical energy consumption of the fan was 7 kw per ton per season.

5 While the user of this installation is thoroughly satisfied with its operation and the rather superficial studies conducted indicate it to be meritorious, on the other hand, we feel that more scientific studies should be made to determine its value for general application.



Left: View of barn on Leete farm used for studies of mow curing of long hay • *Right*: Mow space in the Leete barn equipped for curing studies

Castor Bean Hullers

By E. D. Gordon
MEMBER A.S.A.E.

NOW THAT the war has brought a great increase in the demand for castor beans as the source of a special type of oil required for several technical purposes, and because adverse shipping conditions are restricting importations, production of this crop in the United States or nearby countries is highly important. During the past few years interest in domestic production has shown a steady increase, mostly in Texas and the lower Mississippi Valley, but the handling of the crop has not been mechanized, particularly the hulling, which is difficult, although some attempts have been made to develop a device for the purpose. Most of the imported castor beans, largely from India and South America, have been produced by more or less primitive methods.

There was considerable production of castor beans in this country during World War I because of the need for the oil as a lubricant in airplane engines, but production slumped immediately after the war was over. Interest again was revived in 1940 by an experimental program carried on as a private enterprise near Dallas, Texas. In 1941 a limited seed increase program was attempted but proved unsuccessful because of the lack of uniformity of any variety. In 1942 the U. S. Department of Agriculture instituted a pure seed-increase program and distributed seed of varieties having favorable growth habits and non-shattering characteristics in Texas, Oklahoma, Arkansas, Kansas, Missouri, Illinois, Kentucky, and Tennessee.

Considerable attention was given to developing hullers during World War I, however interest in such development was dropped after the close of the war. A little work had been done on the development of a hulling machine in the Great Plains area of Texas a few years previous to 1940 and was reflected in the experimental machine used that year in Texas. The hulling element of this machine consisted of a horizontal cylinder 12 in in diameter, studded with steel spikes ⅜ in in diameter and 2 in long, which was rotated between a feeding hopper and a curved metal grate at about 250 rpm. The unhulled beans, previously removed from stalks and stems, were fed into the hopper above the cylinder. The beating caused by the rotating spiked cylinder was sufficient to break up most of the hulls and force the beans and hulls through the openings in the basket type grate which enclosed the lower half of the cylinder and extended to the lower edge of the feeding hopper. The threshed beans and hulls dropped upon screens which separated the hulled from the unhulled beans, after which an air blast removed the hull fragments and "pops" (light undeveloped beans) from the former.

With some varieties of castor beans this huller worked satisfactorily, except that the screens frequently became partially clogged with lodged beans, making complete separation of hulled from unhulled beans practically impossible. With other varieties of beans, such as the Conner, the breakage of hulled beans was excessive in this type of huller cylinder.

Before attempting to hull the beans harvested from the 1941 crop, this machine and other types of hullers were observed in order to devise a method of hulling which would do the job with as little damage to the beans as possible.

Among the machines observed was a small experimental model consisting of an inverted conical rotor mounted vertically and turning inside a funnel-shaped housing at a close distance which diminished toward the small end. The rotor was covered with rubber matting and the housing was lined with a smooth rubberized fabric underlain with sponge rubber. The rotor turned at speeds ranging from 125 to 150 rpm. The beans were fed into the top and discharged at the bottom or small end of the funnel. No cleaning or separating devices were provided with this experimental unit. The hulling efficiency was exceptionally good and the number of damaged beans was less than one per cent. The hull was cracked and removed by the moderate pressure and rolling action and the smooth coated bean readily fell to the outlet of the machine. The capacity of this unit was rather low and the arrangement for the vertical drive presents a slight disadvantage; otherwise the principle has much merit.

A small huller of the double endless belt type much like the old army huller used in 1918 was built by the author and tested. The belts and pulleys were mounted between two wide boards which formed the housing for the huller. The lower side of the upper belt and the topside of the lower belt traveled parallel, close to each other, in the same direction. The upper belt traveled 38 per cent slower than the lower one whose surface speed was computed to be 1,200 fpm (feet per minute). The unhulled castor beans were fed to the topside of the lower belt and the abrasive action of the belt surfaces traveling at different speeds removed the hulls from the beans. Test runs on beans of the U. S. type showed that about 72 per cent were hulled and 2 per cent were cracked.

On the basis of these tests, the belt type had a capacity of 650 to 700 lb of hulled beans per hour per foot of belt width. Although this machine showed some promise as a hulling unit,

Article prepared especially for AGRICULTURAL ENGINEERING. The work reported in this paper is based on cooperative studies between the Bureaus of Agricultural Chemistry and Engineering and Plant Industry, Agricultural Research Administration, U. S. Department of Agriculture. (The agriculutral engineering activities have since been transferred to the Bureau of Plant Industry, Soils, and Agricultural Engineering.) Author: Agricultural engineer (BPISAE, ARA), U. S. Department of Agriculture.

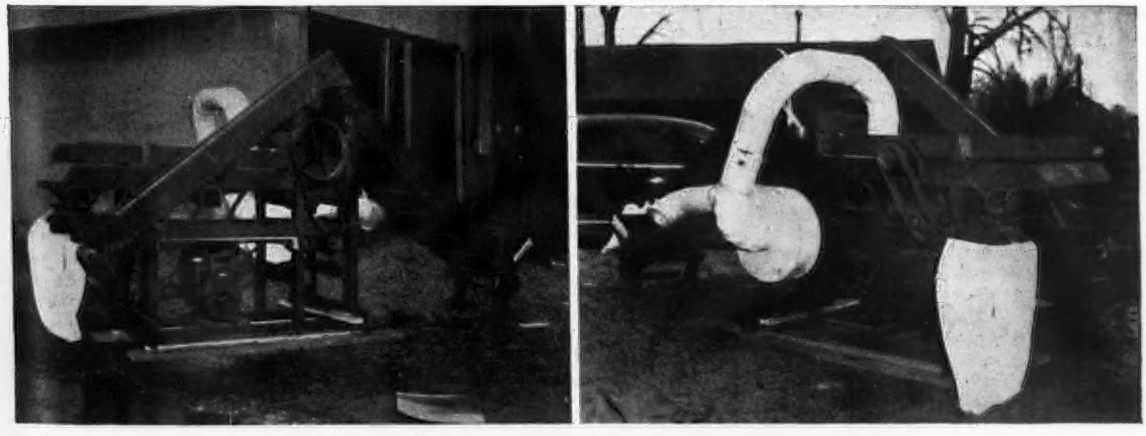


Fig. 1 The USDA castor bean huller as viewed from either side of the machine

it would require considerable space for such an arrangement in addition to a cleaning and separating device having a sizable capacity.

In view of the above preliminary studies, efforts were concentrated on adapting to the fullest possible extent equipment which was already in production. The removal of the hulls, separation of the hull fragments from the beans, and, finally, separation of the unhulled portion of the beans from the sound hulled beans constituted the task for a successful, practical, workable machine. For accomplishing these things, a small threshing machine seemed to have possibilities, and for further investigation of the problem a small combine of the latest design was made available. The obvious advantage of this machine for the study lay in its wide adaptability in speed changes, control of the air blast, arrangement of the chaffer sieves and cleaning screens, and adjustment of clearance between cylinder and concaves.

The flail type cylinder with the rubber-faced angle bars was replaced with a cylinder covered with heavy rubber matting. The concave surface was covered with rubber matting having a very slightly grooved pattern. The speed of the cylinder was cut to about 400 rpm and motive power for the unit was provided by a 5-hp electric motor. Tests on the machine equipped in this manner, using U. S. beans, showed that 85 to 90 per cent or more beans were hulled and 1 to 5 per cent were cracked. The machine had a capacity of 2,400 lb per hr, although under actual threshing conditions the measured capacity was in excess of 3,600 lb per hr.

Several disadvantages, however, were observed during the course of hulling the 1941 crop. Certain varieties, such as the Conner, were badly damaged by the cylinder action as well as by the conveyor buckets. The rubber matting on the cylinder and concave required frequent replacement, as a result of wear by sticks, stones, pieces of metal, soil clods, etc. In attempting to hull beans harvested on the spike the tough woody stems cut away the rubber rapidly. The machine did a poor job of screening out hulls and trash and of separating sound hulled beans from the unhulled beans.

A small huller employing the rubber-covered cylinder and concave was built and operated concurrently with the above mentioned machine during the winter of 1941-42. A wooden paddle-wheel type of fan furnished an air blast for removal of the hull fragments and "pops". In addition, a cylindrical screen, open at each end, 11 in in diameter and 36 in long, was used for screening out the good beans. The unhulled beans were picked up and fed back into the machine. With the Conner and Kentucky-38 varieties, the proportion of cracked beans was held under 5 per cent. While the screening cylinder tended to be self-cleaning to a moderate extent, the actual screening area of the cylinder was such a small proportion of the actual available screening area that it caused a very low output. The output of this machine was about 5 bu an hr.

The principle of the rubber-covered cylinder rotating at a fixed clearance from a rubber-covered concave was later incorporated into a machine to which was added rotary screens of greater length. The first section allowed the cracked beans and small undeveloped beans to be screened out, while the second allowed the good beans to be screened out and the unhulled beans to be discharged at the end of the cylinder where they were picked up and run through the machine again. The rotary screen of greater length helped to step up the capacity to a limited degree but it was still the bottleneck.

Opportunity was afforded to observe the operation of a vertical disk type huller developed by Sharp and Arnold of the Tennessee Agricultural Experiment Station. This machine consisted of a rubber-covered disk turning at controlled distance from a stationary rubber-faced disk. The inlet to a small fan was connected to the discharge spout of the huller, and by careful adjustment this fan could be made to do a very complete job of removing hull fragments and "pops". The percentage of beans of the Conner variety that were hulled was very high and that of beans cracked was low. The capacity of the machine was very small, however.

Extensive tests were conducted with machines built on the principle of the paddle-wheel concave grate type of huller commonly used for peanuts. No machines constructed on this principle proved to be practicable.

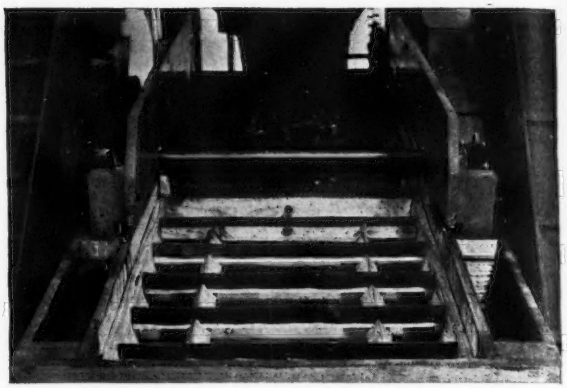


Fig. 2 This view shows the reciprocating type screen wiper which prevents lodging of the castor beans in the perforated screen

The observations thus far indicate that a good castor bean huller should have the following features: An abrasion type cylinder or disk action; peripheral cylinder speed not to exceed 450 to 500 fpm; a cleaning and separating screen of ample capacity for the hulling cylinder and self-cleaning; means of separating out the unhulled beans and conveying them back to the hulling cylinder; and a way of keeping hulls and chaff from accumulating on the cleaning screen. A machine embodying these features was designed and built in the Bureau of Agricultural Chemistry and Engineering and has been called the "USDA Castor Bean Huller."

The various elements making up this huller are shown in Fig. 1. The beans are fed to the hulling cylinder through a conveyor (a canvas belt 20 in in width with wooden cross slats every 16 in) driven by the top roller shaft. The belt is supported on a wood framework anchored to the main frame of the huller. A board adjustable in height and extending across the conveyor governs the depth of beans on the conveyor and prevents choking of the cylinder.

The hulling cylinder is of wood, 8 in in diameter and 24 in long, covered with abrasion-resistant rubber matting secured with large upholstery staples. Rubber matting of similar quality but of different pattern is cemented to the ⅛-in steel-sheet concave facing the cylinder. The pattern on the cylinder matting is a series of 9 x 12-in rectangles, with the longer dimension parallel to the axis of the cylinder marked off with V grooves 3/16 in deep and ⅜ in apart, running at a 45-deg angle to the axis. Grooves in adjacent rectangles were at a 90-deg angle to each other. The pattern on the concave lining consists of shallow V grooves about ⅛ in apart running parallel to the axis of the hulling cylinder.

The concave faces about half of the circumference of the cylinder, beginning about 30 deg past top center. Clearance between the hulling cylinder and the concave is adjusted by tightening or loosening the nuts on the two pairs of bolts supporting the concave. Spring pressure holds the concave in place, and the springs relieve shock when stones or sticks are fed in with the beans since the bolts slide in a cast iron block bolted to the frame.

The hulled beans and the hulls are discharged at the base of the concave, are thrown against a deflector, and slide down a short incline to a vibrating screen. Upward suction from a cleaning fan pulls off the light beans and hulls. The hulled and unhulled beans drop on the screen which separates first the broken beans and particles of dirt and trash and finally the unhulled beans from the hulled. The screen consists of two main parts, the supporting framework and the vibrating table. Flexure members supporting the screen mounting are of hickory and are inclined at such an angle that when vibrated they tend to kick the material on the screen forward and away from the hulling cylinder. Vibration is created by rotating two pairs of weights of about 3 lb each on the ends of a 1-in shaft supported on the upper framework. By shifting the individual weights of each pair slightly out of phase with each other the magnitude of vibration can be increased or decreased. The vibrator shaft *(Continued on page 196)*

Carburetor Characteristics and Fuel Saving in Farm Tractors

By E. W. Schroeder and A. W. Clyde
MEMBER A.S.A.E. FELLOW A.S.A.E.

MOST OF the 1,500,000 farm tractors in the United States are powered by carbureted spark-ignition engines. Farmers are always interested in fuel economy because it is a factor in production costs. A liquid fuel shortage in some sections of the country now is an additional reason for concern about waste of this valuable resource.

In the past, much attention has been devoted to full-throttle economy of tractors and steady progress has been made in that respect. Probably most people in examining a Nebraska tractor test report will look first at the maximum horsepower, and engineers are likely to look next at fuel consumption at and near full load. Probably few give much attention to the part-load tests. Even casual observation, however, will show that part load is the normal for tractors and that full load is comparatively rare. Bateman[1]* gives significant data on a tractor's use during a whole season. Only 23 per cent of the hours were with more than 55 per cent load, and only 3¼ per cent were with more than 85 per cent load. If this is at all typical of farm tractors, it appears that we have been putting the emphasis in the wrong place. Part-throttle economy is then the important thing. If fuel is used economically at part load, then full-throttle economy can almost be forgotten with little effect on the farmer's fuel bill.

Part loads are usually handled most economically by reducing the engine speed rather than by maintaining rated speed and throttling. This gives higher compression pressure and lower friction horsepower loss, both of which make the engine more efficient. Reducing engine speed is often easy in drawbar work. With belt or power take-off work, however, it is not so often practicable because the proper pulley or sprocket may not be at hand. Ways of securing economy at rated speed are therefore important, and this discussion will be concerned mainly with rated speed operation.

About two years ago the authors' interest in part-throttle performance received a considerable impetus when it was noticed that a certain engine used more gallons of fuel at seven-eighths load than at full load. This is analogous to an automobile which would use more fuel on the level than when going uphill. Investigation soon proved that this was due to a richer mixture at part throttle than at full throttle. Interest was naturally aroused as to the commonness of this characteristic. Study of the Nebraska tests shows that tractors do not differ greatly in economy at full throttle when compared on a horsepower-hours per gallon basis. Some differences may be expected since all tractor design is a compromise, but, with a few exceptions, variation in this respect is small.

At part load, however, the story is quite different. Fig 1 shows a wide variation in economy at part load. For each curve, the fuel used in test C, "operating maximum", was taken as 100 per cent and the part-load increase for that tractor figured from that basis. Of course most engines are less efficient at part load than at full load, but one would hardly expect such great differences between engines which are mechanically similar. For example, at half load one used about 21 per cent more fuel per horsepower-hour, while another used 52 per cent more. Suppose each developed 25 hp with full load and each used 18 gal of fuel in 8 hr. If the load were then reduced one-half and the carburetors were not changed, one would use 11 gal in 8 hr while the other would use 13¾ gal. Such a difference seems difficult to justify.

Much work has been done, particularly on automobile engines, on the air-fuel ratio that must be supplied for good economy and performance at various load conditions. In general, it is well known that idling, quick acceleration, and maximum power require a rich mixture, while part-throttle work can be done most economically with a lean mixture. Considerable information about the application of this to auto engines is given by Taub[2] and Lovell et al.[3] The former points out two things that are often overlooked. The first is that the carburetor alone cannot be given all responsibility; the entire induction system including the intake manifold and air filter play a part in the engine operation. The second is that the main opportunity for getting economy is to make the engine burn lean mixtures at part throttle satisfactorily.

To make this discussion more specific, Fig. 2 shows an ideal mixture curve which is believed to be practicable in present engines if the intake manifold gives good distribution. The lean limit curve is based on several references and on tests with one tractor engine. For each test the carburetor was set nearly as lean as would give reasonably good performance and fair response to sudden increases in load. The controls and capacity of the dynamometer permitted reducing the engine speed 50 per cent in less than 5 sec regardless of carburetor setting. In all cases the engine ran smoothly without indication of missing, backfiring, or governor "hunting" except as noted. The suggested ideal mixture is made richer than the lean limit because with present engines there seems to be little gain in economy with ratios much leaner than 16 to 1. Ability to handle a fluctuating load and the need for a manufacturing tolerance also make a margin of safety advisable. These curves must be expected to vary with individual engines, but it is believed they are fairly typical of modern well-designed engines.

In Fig. 2 it is assumed that maximum output at full throttle is desired. Apparently all tractor designers do not want this characteristic. Some seem to be purposely restricting the output by using an orifice in the carburetor which will not give a maximum power mixture at rated speed and full throttle no matter how much the needle valve is opened. This is most likely to be done with the high-compression model when both low and high-compression models are provided. The statement in the Nebraska test reports that the carburetor adjustment used was one giving a certain percentage of maximum power does not indicate much about the mixture strength. In some cases the carburetor may have had a restriction so that the 100 per cent power mixture was still too lean for maximum engine output. No opinion is ventured as to the wisdom of such a restriction, as no doubt good arguments can be advanced for it in certain cases. All that is being done is to call attention to the fact that restricting is sometimes done purposely. It should be emphasized, however, that a lean mixture at full throttle does not guarantee a lean mixture at part throttle.

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*Superscript numbers indicate the references appended to this article.

While the tractor engine is basically the same as the automobile or truck engine, there are some differences that need consideration. The tractor engine covers a narrower speed range, which would tend to simplify the carburetor problem. As opposed to this, the low-compression models are expected to handle a variety of heavy fuels which differ considerably in specific gravity and boiling range. Another difference is that the throttle of the tractor engine is usually operated by speed through the governor instead of being set manually. Possible effect of this on permissible fuel mixtures will be discussed later.

To determine the characteristics of typical tractor engines with respect to mixtures at various loads, and to investigate the possibility of saving fuel by leaner mixtures, a series of tests on seven engines have been made. Most of the tests were at rated speed, but some have also been made at reduced speed. The load was furnished by a Sprague electric dynamometer. Air-fuel ratios were measured as explained in the next paragraph. The general procedure was to adjust the carburetor at full throttle, rated speed, get the air-fuel ratio, and then determine how the ratio changed with part load, governed speed, and the same carburetor setting. If the part-load mixture thus obtained seemed much richer than necessary, leaner mixtures were sometimes tried. If there was any question about governor instability ("hunting") or about reasonable pickup, these were tested by sudden increases and decreases in load. Some engines were run on heavy fuel and some on gasoline. None of the engines had vacuum control of the spark advance. In other words, the spark advance was fixed at the speed used in the tests.

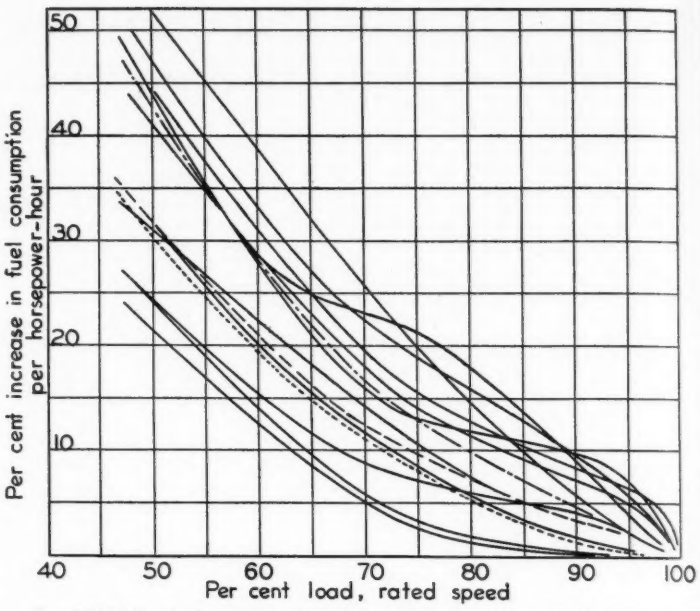

Fig. 1 Variation in fuel consumption of typical tractors at part loads as shown by Nebraska tests

To determine the air-fuel ratio it is necessary to know the weight of fuel and of dry air used. Fuel was weighed on scales sensitive to 0.01 lb. Air was measured by a bellmouthed orifice, a surge tank, and a water manometer reading to 0.001 in on one-half of the difference in water level. Air was passed through the orifice into the surge tank and from there into the carburetor. Three sizes of orifices shaped as described by Bartholemew[4] were available so that the pressure drop into the surge tank could be made approximately the same as the pressure drop caused by the air cleaner. The reference cited contains data on coefficients for the type of orifice described. Fig. 3 shows the water manometer used for getting the pressure drop across the orifice. The neon tube lights when the movable point touches the water. Wiring as illustrated with a polarized plug and receptacle avoids danger of shock from a 115-v circuit.

All air-fuel ratios given in this paper are based on the weight of dry air without including the weight of water vapor accompanying the air.

The weight of dry air flowing through the orifice was computed from

$$Q = AV \text{ and } V = \sqrt{2\,gh}$$

The pounds of dry air per hour

$$= AC \sqrt{\frac{2g}{dm} \times \frac{dw}{12} \times H \times \frac{3600}{Va}} \qquad [1]$$

in which

A = area of orifice, sq ft

C = orifice coefficient

dw = density of water, pounds per cubic foot

dm = density of mixture (air and vapor), pounds per cubic foot at the observed barometric pressure

$Vm = 1/dm$

Va = cubic feet of mixture (air and vapor) containing 1 pound of dry air at the observed barometic pressure

H = head, inches of water

Using 62.3 as the value of dw, equation (1) may be reduced to:

$$\text{Pounds of dry air per hour} = 65{,}800\ AC\ y \sqrt{H/Va} \qquad [2]$$

in which $y = Vm/Va$

Typical value of y at 70 deg, 35 per cent relative humidity, is $y = 0.997$, while at 85 deg, 70 per cent relative humidity, $y = 0.99$.

Data from tests of the seven engines show that carburetor characteristics range from almost the ideal of Fig. 2 to the opposite; that is, a richer mixture at part load than at full load. Two are being given to illustrate the extremes. The others were intermediate.

Fig. 4 is an example of what the authors consider good characteristics at rated speed. This carburetor automatically gives a leaner mixture when throttled than when the throttle is wide open. If this engine were run on gasoline, a fairly uniform fuel, it would seem practicable to make this a fixed jet carburetor and have good economy in most work, together with maximum power when needed. The only fault observed was that the mixture became somewhat richer when the speed was reduced considerably. This demanded readjustment of the needle valve for best results if the speed range was changed several hundred revolutions per minute.

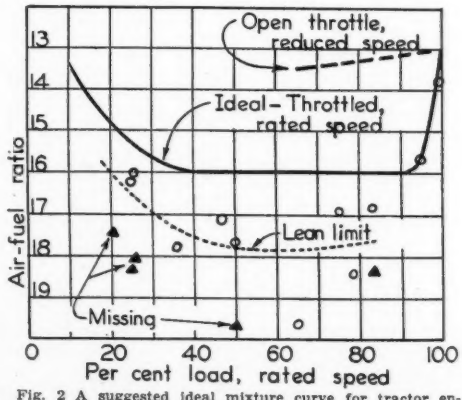

Fig. 2 A suggested ideal mixture curve for tractor engines, also an approximate lean limit for a certain engine

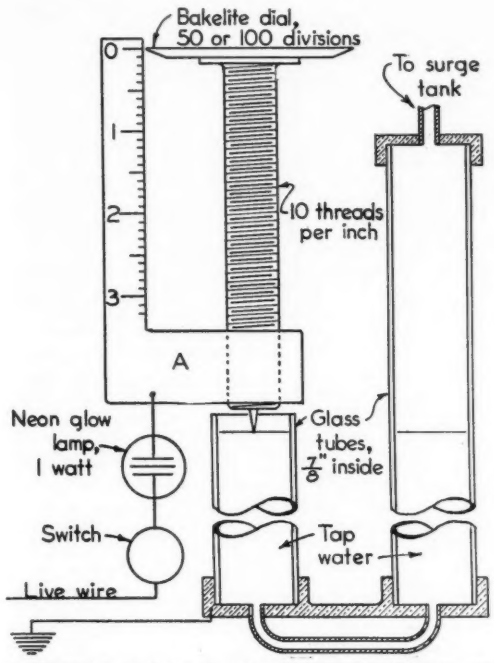

Fig. 3 Manometer used for observing the pressure difference causing air flow through the orifice. The neon glow lamp lights when the point touches the water. Part A is insulated from the water and can be adjusted vertically for the zero position. A polarized plug and receptacle are used to avoid shock if metal parts are touched. (Apparatus suggested by Prof. F. C. Stewart, mechanical engineering department, Pennsylvania State College.)

Fig. 5 is an example of quite different characteristics. If the needle valve is set for full power, two and one-half turns open, a wastefully rich mixture is supplied at part throttle. The 1.9 setting sacrifices considerable power at open throttle, yet gives poor economy at light loads. Economy at part load can only be secured by a setting of approximately 1.3, and if full power is needed it is not forthcoming. If half load for this engine were 12½ hp and this load were carried for 8 hr, the fuel consumption would be:

Needle valve 2.5 turns open	15 gal
Needle valve 1.3 turns open	12.8 gal
Saving in 8 hr	2.2 gal

For the same work, the 2.5 setting requires 17 per cent more fuel than the 1.3 setting. A fixed jet in this carburetor would be entirely unsatisfactory. If the carburetor is adjusted well for nearly full load, then it is wasteful on lighter work.

The authors have yet done only a little testing at full throttle and reduced speed. This is shown by the dotted part of the suggested ideal of Fig. 2. A good power mixture here would seem to demand that the position of the throttle, or the velocity past the throttle, be used to control mixture strength. Two companies making tractor carburetors now use such control. Total air flow into the engine is not enough to enrich the mixture whenever full power is needed regardless of speed. For example, an engine may use the same amount of air at open throttle, 1250 rpm and 74 lb brake load as when running throttled, 1635 rpm and 53½ lb brake load, yet a richer mixture might be wanted in the first case.

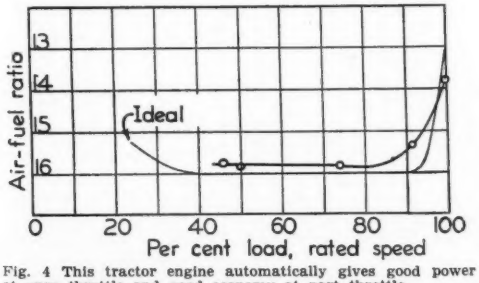

Fig. 4 This tractor engine automatically gives good power at open throttle and good economy at part throttle.

In order to get some idea of the mixtures being used by farmers' tractors at part load, observations were made with a Cambridge exhaust gas analyzer on ten tractors in the field. Only two were using mixtures lean enough for reasonably good economy. The others were rich enough for maximum power or even richer than that. The reliability of analyzers has been reported on by Dilworth[5]. The above make of instrument, which depends on the heat conductivity of exhaust gases, has the same limitation as most analyzers. It is unreliable for mixtures leaner than 14½ or 15 to 1. This point was checked many times by comparing the analyzer readings with those obtained by fuel and air measurement. The chief usefulness of the analyzer seems to be in showing a rich or very rich mixture.

The question will probably arise with others as it has with the authors as to why there should be so much variation in tractor carburetor characteristics. A partial explanation may be that there has not been a strong demand for economy at part load. The user does not even have the rough standard of miles per gallon which he has with a car or truck, hence he can seldom be sure that one engine is more economical than another. Two other reasons are given by men with extensive experience in this field. These are the limitations imposed on the fuel mixture by (1) intake manifolds which give unequal distribution to the various cylinders, and (2) governors which may be unstable with mixtures which are desirable for economy.

Intake manifold design is as yet more of an art than a science. It apparently is one of the problems which engine designers must solve if they are to burn lean mixtures at part load satisfactorily. This problem has apparently been well handled with some of the engines tested, but with others perhaps the intake manifold may be a serious limitation.

With governors, there would appear to be small reason for difficulty when the mixture becomes leaner as less torque is needed. The main chance for trouble would seem to be when the torque is decreasing from about 40 per cent and the mixture is becoming richer. In this load range there may be danger of too rapid enrichment when the governor is trying to reduce the engine's output; in other words, a conflict between the governor and the carburetor. This problem also seems to have been well handled in some cases. The engine of Fig. 5 and another with similar characteristics gave no sign of governor instability of "hunting".

CONCLUSIONS

1 It is seldom practicable to give a tractor engine a continuous full load. Part throttle operation is the normal condition, hence fuel economy at part throttle is more important than at full throttle. In the past economy at full load has been overemphasized and economy at average work neglected.

2 1½ to 2½ gal per day can be saved with many two-plow tractors by reducing the engine speed *(Continued on page 196)*

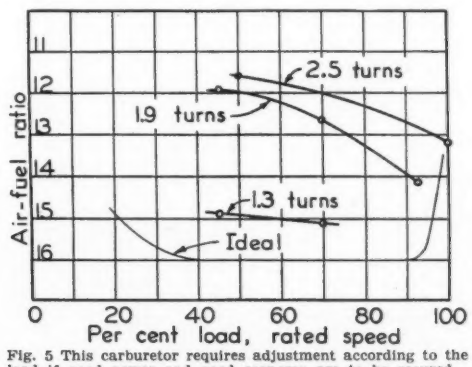

Fig. 5 This carburetor requires adjustment according to the load if good power and good economy are to be secured

Rubber from Guayule

By Harry F. Blaney

THE GREAT need for rubber of any kind, and especially for a certain proportion of natural rubber, has caused the federal Government to intensify investigations into rubber-bearing plants adapted to culture in this country, and to start actual production of the most promising ones. There are a number of such plants, both native and imported, which are capable of producing greater or lesser amounts of rubber. Outstanding among them, however, both in point of rubber yield and developed methods of culture is guayule.

In March, 1942, Congress authorized the Secretary of Agriculture to embark on a 75,000-acre guayule production program, and the Secretary turned the operating phases of the program over to the Forest Service. Research in connection with the program was vested in the Bureau of Plant Industry, and such bureaus as Agricultural Chemistry and Engineering, Entomology and Plant Quarantine, and the Soil Conservation Service furnished technicians in their respective fields.

Guayule rubber is the same kind of rubber as that produced by the Hevea tree of the East Indies, and while the two have slightly different properties in some respects they are readily interchangeable for most purposes. Guayule rubber makes excellent tires, used either alone or in conjunction with other rubbers. Above all, to quote the Baruch committee report, it represents "the principal source of crude rubber which could not be lost to us short of conquest of American territory."

Unlike the Hevea rubber tree, where the rubber is contained in fluid form and is drawn off by tapping the tree, the guayule shrub deposits pure rubber in the cells of the plant itself, under the bark. It deposits the rubber when soil moisture begins to run short, so for most effective rubber production the plant requires a relatively short, wet growing season followed by a long dry period. If moisture is available for growth during too much of the year, a large shrub is produced, but it contains little rubber. Recent studies also indicate that cool temperatures, at least at night, are essential to rubber formation.

The guayule plant deposits some rubber each year of its life, and may live for 30 years or more. However, under cultivation the peak of production is reached during early maturity, and since the plant is destroyed in recovering the rubber, the most economical cropping period is four or five years. Under optimum growing conditions it will produce from 1200 to 1800 lb of rubber per acre during such a period, the rubber content ranging from 18 to 22 per cent of the dry weight of the shrub. During the present emergency, however, it is planned to harvest the crop at the end of the second season in the field, and in order to get a comparable tonnage of shrub per acre the seedlings are planted more thickly. This will naturally increase the per pound cost of the rubber, but it will also materially bring nearer the day when the rubber will be available for use.

The Indians of northern Mexico knew about guayule rubber and made some slight use of it before the advent of the white men. It was not until about 1904, however, that large-scale production of guayule rubber got under way, with the erection of processing plants in Mexico and Texas, one of the early operators in Mexico being the Continental-Mexican Rubber Company. In 1912 the company decided to try domesticating guayule in southern Arizona. There experimentation was started looking both to improving the productiveness of the plant and to finding locations suitable for growing it commercially.

Later it was decided that the Salinas Valley of California offered the best climatic conditions for both continued experimentation and commercial production, and the operation was moved there in 1924-25. A mill capable of producing about 10,000 lb of rubber per day was built, and since that time some 8,000 acres of guayule have been grown in the valley and processed in the mill. The name of the company had in the meantime become the Intercontinental Rubber Company.

Because of the generally low world price of rubber, however, the company had never felt justified in embarking on a large production program, but it did perfect machinery and methods of culture and processing adapted to production on any scale should occasion ever warrant expansion. Of still greater importance, when the country began looking for a source of rubber supply to take the place of East Indian imports, was the fact that some 23,000 lb of seed from the best strains of guayule had been collected and were in storage available for planting. This seed, together with all its equipment and properties in California, and patents in this country, the company offered to the government. By a law enacted March 5, 1942, Congress authorized the Secretary of Agriculture to acquire them, and to embark on the 75,000-acre production program already referred to.

As previously stated the operating phases of the guayule program are being conducted by the Emergency Rubber Project of the U. S. Forest Service. Within a matter of days, after authorization was given, ground was being broken for huge new nurseries as the first step in getting the program under way.

Three nurseries containing 530 acres were created from leased farm land and equipped with overhead irrigation systems. These nurseries contain nearly 12,000 seedbeds, each 4 ft wide and 400 ft long, and are capable of producing 350 million or more seedlings suitable for transplanting. They were seeded with the entire 23,000 lb of seed acquired from the company.

Using seedlings growing in the company's nursery at the time, 900 acres of guayule plants were set out on land leased in the Salinas Valley. The government took over from the company some 600 acres of guayule plantations of various ages. Some of the plots are now mature and can be harvested any time they are not needed for seed production.

Guayule reproduces by means of seed and seed collection is thus one of the vital elements of the cultural program. The seeds being very light and borne on slender upright stems, the company had developed mechanical pickers which utilize the vacuum principle to suck the seeds up into a container. While the project resorted to hand picking in the fields during its first season in order to get every possible pound of seed, mechanical collectors are practicable and satisfactory under normal conditions. When it was found that the seedlings in the nursery beds were preparing to produce a good seed crop, an entirely new type

This picture shows the operation of baling guayule shrubs for transportation to the factory where the rubber is extracted

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Paper presented at a meeting of the Pacific Coast Section of the American Society of Agricultural Engineers at Logan, Utah, February, 1943. Author: Irrigation engineer, Emergency Rubber Project, Forest Service, U. S. Department of Agriculture.

(AUTHOR'S NOTE: This paper is prepared from information released on rubber from guayule by the Emergency Rubber Project, U. S. Forest Service, Dec. 18, 1942.)

of machine was invented to harvest it and the same principle is being extended to equipment to work in the younger fields.

All of the guayule plantations put on a heavy seed crop during the 1942 season, and about 170,000 lb, clean weight, was collected. This was a great deal more than had been expected, and made it possible to expand the program more rapidly than at first anticipated.

Guayule seed does not germinate readily if planted in its natural state, but after several years of experimentation Dr. W. B. McCallum, chief botanist of the International Rubber Co., evolved a process of treatment before planting which results in germination of a satisfactory proportion of it.

After collection the seed is run through a fanning mill to remove trash and chaff and is then placed in a tank of water where it is allowed to soak for about 22 hr, being meanwhile mechanically stirred. At the end of this period the water is drawn off and the bath refilled with a ½ to 1½ per cent solution of calcium hypochlorite or sodium hypochlorite. The seed is soaked in this solution for from 2 to 4 hr, when it is again washed to remove the excess chemical. It is then put through a centrifuge to remove surplus water, and finally dried in a mechanical drier. When the moisture content has been reduced to a given point, the seed is packed in airtight drums for storage. It may also be stored as it comes from the field but must in any event be treated as above described before planting, unless it has been in storage for several years, when the treatment may be diminished or even dispensed with. Seed may be stored for several years without losing its viability, thus permitting a supply to be kept on hand against lean seed-production years. When it is desired for any reason to have the seed come up quickly after sowing, it is partly germinated in trays placed in a chamber where temperature and humidity are kept under careful control. Pregerminated seed must be sown when it is ready, however, regardless of soil or weather conditions, which militates against the use of the practice unless there is some special reason for it.

The seed is planted in the nursery bed by an ingenious seeding machine which sows a complete bed (7 rows) at one time. Essentially the machine lays the seeds on top of a finely prepared seedbed, then to keep them in place flows a thin layer of white sand on top of them. Immediately the bed is sown, it is wet down with the sprinkling system and is sprinkled frequently thereafter until the plants are up and have struck root. Thereafter they are watered less frequently, though they are always given sufficient water to keep them growing at the rate desired. The beds must be kept free of weeds, and on new land this may prove to be a problem. While especially designed cultivating machinery cleans the space between the rows, weeds in the rows must be removed by hand. To give some idea of the magnitude of the job, during the first growing season at the Salinas nurseries it was necessary to recruit some 3,000 workers, largely women and girls, to clean the beds of the weed crop that came up.

Once the young plants become established they grow rapidly, and in from four to five months are ready for transplanting. They are reduced to uniform height by a machine which clips the tops, and are then loosened in the bed by a blade drawn along under the plants which cuts the roots and shakes them loose. They are then collected by hand, sorted, and the usable plants packed in boxes with wet moss or shingle-tow about the roots, for shipment to the field.

The seedlings are transplanted in the field by means of tractor-drawn planting machines, which plant four rows at a time. For each row a subsurface tool opens a slot in the earth deep enough to accommodate the roots of the plants. Planters on the machine—one for each row and either men or women—feed seedlings into moving clips which in turn insert them in the opened slot. A pair of packing wheels which follow close the slot and firm the soil about the roots. The rows are planted 28 in apart and the plants spaced from 20 to 24 in in the row, depending upon the character of the planting site and whether or not the land is irrigated. The machines plant about 10,000 seedlings per hour on the average, or 10 acres per 10-hr day. It is a job for nimble fingers; the planter must handle something like a plant a second while the machine is in operation.

Like any other row crop, guayule must be well cultivated and kept clean. While it is true that it grows wild in its native range, it grows very slowly there and in addition is in association with a group of plant species with which it can live in harmony. It will not compete with weeds and grass on agricultural land and make sufficiently rapid growth to justify occupancy of such land.

The shrub is harvested by a machine which digs out the plants, including the principal roots. After a three-day curing period it is either chopped up into coarse chips or baled and transported to the factory. The shrub is delivered to the baler by a buck rake propelled by a tractor. If properly protected, baled shrubs may be stored for 60 days or more prior to milling, without appreciable deterioration of the rubber content.

Guayule does not appear to have many important natural enemies. A few insects notably grasshoppers and June beetles may damage it, and some mammals, including sheep and goats, will eat the plant. It also is not subject to many serious diseases. The principal ones are certain root rots, which ordinarily occur, however, only when the plant finds itself on heavy or poorly drained soil, and a crown rot which may appear if water stands around the plant. These diseases may be aggravated by any condition which prevents normal drying of the topsoil. Plants just emerging from the seed occasionally fall victim to the "damping off" fungi, common to a great variety of plants, but it generally is not serious in the nurseries. In short, like most desert plants, guayule is pretty tenacious of life once it gets started.

When the chipped shrub is brought to the factory, it is dried and put through a series of rolls and mangles which reduce it to a very finely shredded condition. This material, with a carefully controlled addition of water, is then fed into the upper end of a series of "pebble mills". The pebble mill is a long tube lined with very hard silicon bricks and partly filled with a special kind of smooth pebbles. The tube rotates and the material in it is thus ground between the pebbles and the lining, separating the rubber particles from the plant fibers. Emerging from the last of the tubes, the mass goes into a settling tank where the waterlogged woody material sinks and the rubber floats to the surface, the particles agglomerated in the form of "worms".

These worms are then put through certain cleaning processes, where the last of the plant fibers are removed. The rubber is spread out on trays and dried for three or four hours in vacuum driers, and then pressed into slabs weighing 100 lb. Two of these slabs are packed per box for shipping purposes.

Guayule rubber extracted by this process contains about 16 per cent of resins. These resins are not mixed with the rubber in the plant, but become unavoidably mixed with it in the milling process. For some products the resin content is not objectionable; for others it must be removed or diminished. Tree rubber contains about 4 per cent of resins. Since the war began, resins such as are contained in guayule rubber have become valuable in the manufacture of plastics, so that the deresinating process, where it is necessary, may now pay its own cost.

During the summer of 1942 about 350 million seedlings were produced in the Salinas nurseries, sufficient to plant some 32,000 acres of land. In addition, two new nurseries, each containing about 10,000 seedbeds, are being established in southern California. This expansion in nurseries was made possible by the large amount of seed collected in 1942. When all of the nurseries are fully in production, it is expected they will produce seedlings for an annual planting program of around 200,000 acres.

Past research on the yield of rubber from guayule grown for less than the optimum period is slight, but on the basis of what evidence exists if the above planting and harvesting program is carried out it should result in the production of about 80,000 tons of rubber annually. This goal will not be reached at once, of course. This year only about 600 tons will be milled, while the harvest in the winter of 1944-45 should produce around 21,000 tons. Thereafter the program will be in full swing.

It is planned to use both irrigated and dry land in the production program. Since irrigated land may ordinarily be expected to produce more rubber in a given length of time than dry land, for the time being at least the greater part of the acreage will be confined to it.

The land is obtained by leasing from owners. Since the project's appropriation is on an annual basis, the lease is taken for the period from date to the following June 30, with an option

on the part of the government to renew annually for a total period of ten years. The rental rate is arrived at by an appraisal method similar to that used by lending institutions, and negotiation with the individual owner.

Production of guayule rubber from plantations has so far been on so small a scale and costs have been so influenced by the developmental character of the operation that there are no existing figures that would be of much value in forecasting the cost of such rubber under full-scale production. The present governmental production program is a war effort aimed entirely at helping to relieve the very critical rubber situation, but it is not beyond the bounds of possibility that it may also result in developing both a permanent at-home source of rubber and a profitable crop for agriculture. As a crop it is "easy" on land, occasioning less drain on soil resources than many other crops, and since genetic research in connection with the plant itself is really only in its infancy, there is every probability that both its productiveness and its tolerance to growth conditions will be improved.

A greater part of the land now being leased for growing guayule is irrigated. The irrigation water is obtained by pumping from individual wells, irrigation districts, mutual water companies and other types of irrigation enterprises.

Before the land is leased from the owner it is necessary to determine the adequacy of the water supply and the irrigation system. Information is obtained on the quantity, quality, and cost of irrigation water. A survey of the land is made to determine whether the land can be irrigated by furrows, as this method is the most satisfactory system for irrigating guayule. Members of the staff of the division of irrigation, Soil Conservation Service, have been detailed to the Emergency Rubber Project to make these irrigation studies, as well as to advise on irrigation practices after the land has been leased.

When the land lease has been completed, the government takes over the entire program of land preparation, planting, irrigating, cultivating, and harvesting. Thus the government inherits all the problems confronting the average farmer growing crops under irrigation.

Very little is known of the response of guayule to different soil moisture conditions or the irrigation water requirements of the crop and studies are being planned of some of the factors affecting guayule production under irrigation.

Castor Bean Hullers

(Continued from page 190)

is rotated at about 700 rpm and the travel of the screening table is about 3/16 to ¼ in. The clear screen area is 20 x 60 in. The first half of the screen area has oval perforations ¾ x 14/64-in, and the other half oval perforations ¾ x 19/64 in. The 19/64-in opening appeared to be the best suited for separating the hulled from the unhulled beans of the Conner variety. However, the experimental machine was equipped with screens having perforations 18/64 x ¾ in and 20/64 x ¾ in for other varieties.

The unhulled beans are conveyed back to the hulling cylinder while the hulled and cleaned beans are sacked at the discharge spout which is equipped with a two-way valve.

The vibrating screen aided by a wiping device completely eliminates clogging. As shown in Fig. 2, this consists of a framework of wood slats extending laterally across the screen and mounted on slides so that the rounded tops of the slats touch the underside of the metal screen and push any lodged beans upward. The slats are about 5 in apart and the length of travel is about 6 in. They are moved lengthwise of the screen by crank motion, at a rate of about 15 strokes per minute. This scheme, which proved entirely effective, was worked out in cooperation with A. P. Bell of the Medley Manufacturing Company.

The hulling cylinder has a capacity of 26 bu an hr when hulling the Conner or Kentucky-38 variety. Five of these machines, designed by the Bureau of Agricultural Chemistry and Engineering for the Commodity Credit Corporation, were built for use during the 1942-43 hulling season commencing about December 1. In the construction of these five machines particular stress was placed on the use of non-critical materials. Oak lumber was used in the construction of the huller framework and the conveyors.

In using this huller best results are obtained by first removing the beans from the spikes. The rubber-faced cylinder and concave are capable of removing the beans from the spikes but this causes severe wear and tear on the rubber surfaces. The ordinary flail type cylinder of a small combine, running not over 1,000 fpm peripheral speed, will remove the beans from the spikes. The spikes and any other trash likely to be injurious to the rubber-covered surfaces can be carried out over the straw rack and the bean pods can be directed to the tailings elevator which will carry them to the auxiliary castor bean hulling cylinder. The flail type cylinder will not hull many of the beans but serves a useful purpose in getting the pods off the spikes. It is felt that such a scheme can be readily adapted to existing equipment, except for the cleaning screens. Incorporation of the cleaning screens with the feeding table for auxiliary hulling cylinder would make entire attachment one complete unit. The overrun from the cleaning screen would be fed into the hulling cylinder, while any hulled beans would fall through the screen to the sacking spout.

To hull and clean castor beans in an adequate manner and prevent undue damage to the beans, care must be taken to keep cylinder speeds low and to provide for uniform distribution of beans and hulls throughout the air stream as they are discharged from the hulling cylinder and before they touch the separating screen. Screens for removing foreign matter and broken beans can be used effectively with no clogging if the simple wiping device described is used.

It seems evident that castor bean hullers can be readily designed as auxiliary units to be attachable to existing threshing machine equipment.

ACKNOWLEDGMENT: The author wishes to ackowledge the help and advice given by Dr. D. M. Crooks, chief, division of drug and related plants, Bureau of Plant Industry, and of his staff, and by R. M. Merrill and I. F. Reed of the Bureau of Agricultural Chemistry and Engineering, in the conduct of this study.

Carburetor Characteristics

(Continued from page 193)

when that is practicable. Full speed must sometimes be maintained, in which case economy at part throttle is important.

3 Considerable variation exists in the fuel economy of tractors when throttled, the variation being greater than at full throttle.

4 Good economy at part throttle requires that the engine be designed to burn lean mixtures satisfactorily and that the carburetor automatically supplies such a mixture for part load work. The construction around the valves, the intake manifold, the governor, and the air filter are probably factors in the engine's ability to operate well on lean mixtures.

5 The fact that some tractor engines now give good power output at full throttle and good economy at part throttle shows that the above matters of design are not impossible of solution.

6 The wide differences in economy at part loads now existing among tractors suggest two courses of action as follows:

(a) For the present, the situation is that many tractors in use will benefit by adjustment of the carburetor according to the load. When full power is needed for heavy work, the carburetor needs adjusting for that condition. If the tractor then is used for lighter work, the carburetor should be adjustable for the right load. The practicable course for the owner seems to be to experiment with his engine as best he can to determine whether such readjustment is necessary.

(b) For the future, the problem is to improve the characteristics of some engines and their carburetors so that they will be nearer the best in this respect; that is, they will deliver a better combination of power and economy with one carburetor setting.

REFERENCES

[1]Batement, H. P., 1943. Effect of full loads on farm machine operating economies Agricultural Engineering 24(4) 111-114.

[2]Taub, A., 1938. Motor cars in England. S.A.E. Transactions 42 (6) 229.

[3]Lovell, W. G. and others, 1941. A 13-year improvement in mixture ratios. S.A.E. Journal, 48 (4) 160-164.

[4]Bartholomew, Earl, 1936. Discussion, S.A.E. Transactions 38 (3) 97.

[5]Dilworth, J. L., 1941. Characteristics of exhaust gas analyzers. S.A.E. Transactions 48 (6) 234-239.

Planning Farms for Management of Runoff Water

By Marion W. Clark
MEMBER A.S.A.E.

OUR AIM has been a broad approach to problems of farm production and conservation in the studies we have conducted in Missouri. We have ample proof both from experiments conducted and practical observations that the maximum production of our sloping land (which includes all but about one-sixth of the state) can not be attained for even a year, to say nothing of a period of years, without observing the mechanical principles of water and soil conservation with a well-planned system of farming. We call the complete system "balanced farming". This embodies proper use of land, soil treatments, crop rotations, and livestock management, and included in this coordinated plan are the fundamental principles of the proper use of rainfall. This then, provides for maximum yields and minimum damage from excess runoff water. The proper use of and absorptive qualities of organic matter are not overlooked or minimized in the plan.

Our soils specialists tell us that 90 per cent of the plant food available to plants comes from rotting or decaying organic matter in the soil. Most of the accumulation of organic matter is made possible in a practical way on our sloping farms only by the incorporation of mechanical means of controlling runoff water which results in preventing the removal of tremendous quantities of topsoil with its organic matter content. Neither is the effect of cover crops, mulches, etc., overlooked in the basic plan for maximum use of rainfall and maximum control of runoff water. However, the structural features of the system of balanced farming are what we refer to as the "water management system".

We consider the rainfall for a given tract of land as a valuable application of an essential element of production and one that can do as much harm as good if not properly managed. I can think of few things that could so universally paralyze our whole production program next year as to have the water cut off. Yet on many farms

Paper presented at the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1942. Author: Assistant professor of agricultural engineering, University of Missouri.

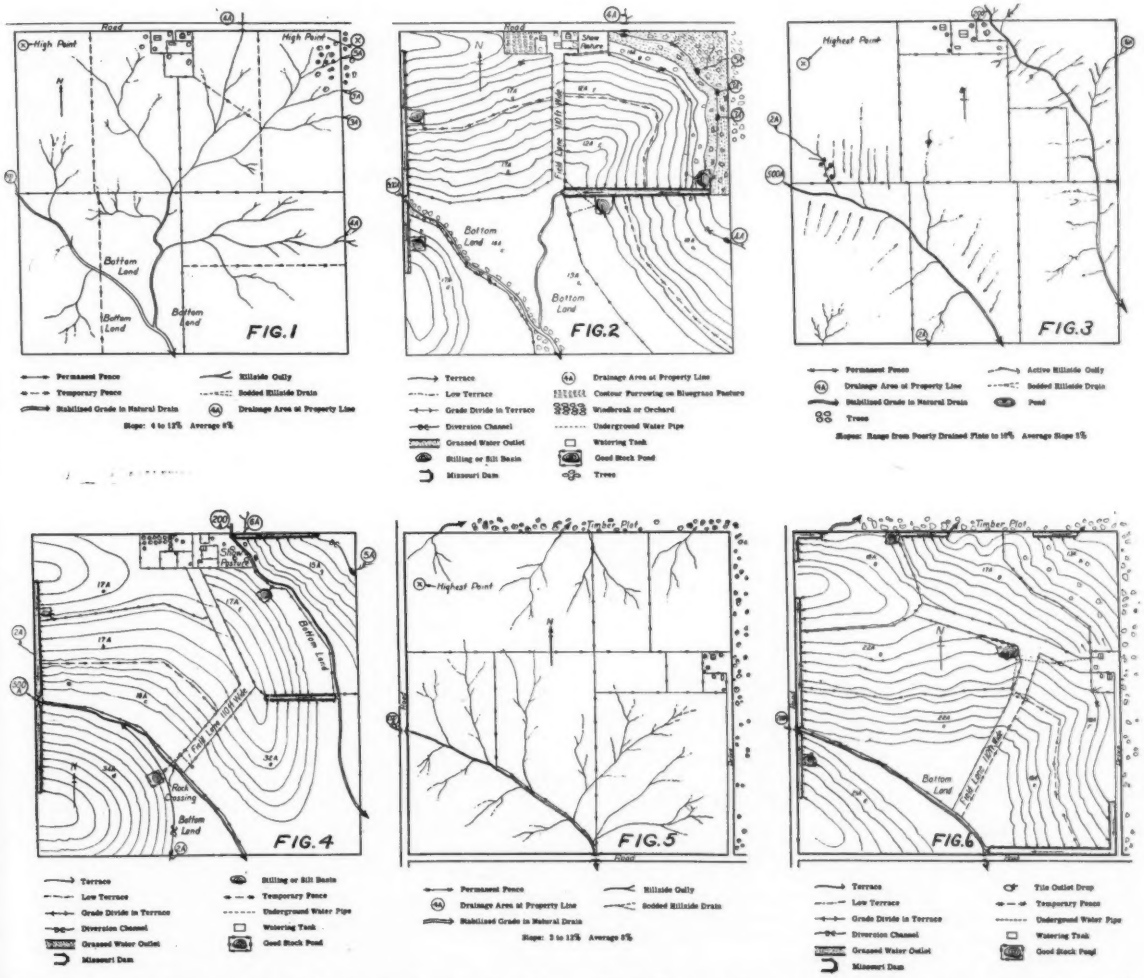


Fig. 1 Drainage and erosion pattern of a Harrison County (Mo.) farm before putting a water management system into effect • Fig. 2 Same farm as in Fig. 1 two to ten years after completing water management system • Fig. 3 Drainage and erosion pattern of a Shelby County (Mo.) farm before putting a water management system into effect

Fig. 4 The same farm as in Fig. 3 two to ten years after completing water management system • Fig. 5 Drainage and erosion pattern of a Lincoln County (Mo.) farm before putting a water management system into effect • Fig. 6 Same farm as in Fig. 5 two to ten years after completing water maangement system

throughout the United States that is, in effect, what has been allowed to happen and is now happening. Fields with most or all of the topsoil gone not only lack the fertility but do not retain enough of the water, except under most ideal rainfall conditions, to prevent moisture being the limiting factor of production sometime during the season. Many of our fields fail to produce enough crops to offset the cost and energy of producing them. This certainly is a zero war effort. Valuable plant food, organic matter, lime, fertilizers, manure, etc., are carried away with the uncontrolled water that is also being wasted for crop use, thus further decreasing yields and jeopardizing future production.

With steep or long slopes and land rotated to small grain and row crops for maximum war production, the use of a comprehensive system of terraces, terrace outlets, contour farming, diversion channels, and soil-saving dams is necessary to make maximum use of the water and minimize damage done by intensive and excessive rainfall. Many farms will require only terraces and contours in addition to good farming practices, while many others will require all the above-mentioned and others to complete a sufficiently effective water management plan. Many farmers want to use only gully control measures in a drive to control erosion without seeing overall problems and comprehensive solutions.

The accompanying illustrations show some actual water management plans now in use in Missouri. These plans were not picked because they are spectacular or unusually well-suited. Neither are they chosen because they are unusually difficult, but rather to represent a fair cross section of problems encountered on the averaged sized farm throughout the state.

The farmer must work closely with the county extension agent and must have the final word on whether a particular practice is to be used on his farm. If he can't be sold on it, the advisability of pushing it onto him is questionable, regardless of how good it may seem to the technician. The major problem we have found is selling the farmer on the correct start. He can usually be started correctly only through logical reasoning in terms of his thinking and his intended plans on that particular farm.

THE WATER MANAGEMENT PLAN AS COMPLETED SHOWS THE FIELDS ARE MORE ACCESSIBLE TO THE FARMSTEAD

The farm in Fig. 1 had the drainage and erosion pattern shown before any terrace or runoff management work was done. Fig. 2 shows the same farm with the plan completed. Most of the work is now completed and certain principles have been observed to give maximum satisfaction of farming operations and maximum efficiency when applied on this farm as well as when applied to many other farms, some of the more important of which are:

1 Fields are accessible to the farmstead with a minimum of crossing terraces or outlets. A well-planned roadway and stock lane is provided, which is one of the first essentials to be observed.

2 All gullies are controlled permanently by having water removed from them. Sheet wash is controlled by shortening slopes plus good soil and crop management, resulting in more moisture for crops to use, protection of organic matter, lime, etc., at a cost far less than the cost of any system of gully control that could be used to control the gullies with the water left in them.

3 Fields are approximately equal in size so a good rotation can be worked out to allow maximum efficiency in the operation of power and labor, as well as in the livestock carrying capacity of the farm from year to year.

4 A minimum of outlets consistent with maximum length of terrace and field accessibility is used.

5 Outlets are all located on field or property boundaries. A number of so-called natural draws or gullies could have been used. Such outlets have consistently given dissatisfaction because of splitting fields and causing extra point rows, difficult maintenance, extra fencing, usually more difficult to build and unless properly constructed and properly protected last only a few seasons until a gully results.

6 Fields divided on the contour to facilitate contour farming. This is not done all at one time and temporary fences are used until the owner is sure of the location of the permanent fence.

7 Diversion channels and dikes are used to cut out small head water of all gullies not originating on the farm.

8 All hillside gullies eliminated and only main stabilized drainageways used.

9 All water falling on farm is given some time to soak into the ground and increase crop yields, while the excess is taken off slowly and leaves the topsoil with organic matter, lime, fertilizers, and manure to grow crops and hold more moisture for this and other years.

10 Permanent, rocky, or timbered pasture is contour furrowed to conserve needed moisture and reduce runoff.

11 Good grass outlets are constructed and protected from runoff until they become well sodded. This requires 10 months to one year if properly treated and seeded. Outlet construction could well be elaborated upon if time permitted.

12 Missouri dams are used to let the water from the end of the grass outlet into the bottom of the main stabilized drainageway.

13 The field lane is a pasture strip but wide enough to prevent a bare lane or waste area being formed. Water is intercepted from any path or implement track and taken into the upper end of a terrace on either side.

14 A heavy load may be hauled to or from any of these fields without crossing any terraces or any terrace outlets. In this plan, two fields would require extra travel, however, to avoid crossing any terraces or the outlet. This is one point that is debatable on this plan, and except for much greater expense in construction and the inability to sell the owner at the time, an outlet at the south end of both back fields would have been preferred. After pointing this out and discussing the merits of both systems, the owner decided on the system used since these back fields will also be in grass crops more than other fields on this farm.

15 Good stock water is available to all fields.

16 A direct passage is provided to bottom fields which are to be farmed most.

Fig. 3 shows a somewhat different type of drainage pattern, and Fig. 4 shows the plan decided upon and being executed. The advantages and principles of the plan are similar to those in Fig. 2. I believe if the owner had this one to do over he would turn the terraces around on the northeast corner and go to the considerable extra expense necessary in building an outlet along the east side and down to the creek along the field boundary so as to give a more directly accessible route into this field for hauling manure, etc., without crossing the terraces.

THE PLAN SHOWING IN FIG. 6 PROVED ONE OF THE MOST SATISFACTORY SYSTEMS FROM AIR OPERATION STANDPOINT

Fig. 5 shows another farm with still another type of drainage pattern. Probably this is the most difficult one to plan and construct in some respects because of the complete rearrangement of inside fences and larger than usual number of outlets required because of topography. It is, however, one of the most satisfactory water management systems from an operation standpoint. This is most important if pride and complete satisfaction are maintained through the years to come in operating machinery on the farm and keeping the system properly maintained. In no field on this farm is it necessary to cross terraces or outlets or travel extra distances to avoid this. In no field is there an excessive number of short or point rows.

The satisfaction and pleasure of operating such a system over a period of years cannot be overestimated, and the time required to build such a system has to be balanced against the shorter time or lower cost of other systems that might have been used with a measure of dissatisfaction to the owner thereafter or until he went to still more expense to change it. A good system has a tremendously favorable effect on the individual farmer in starting the whole program moving forward in his community on a sound basis.

The pleasure and pride of operating a well-planned, comprehensive system, together with the readily noticeable increases in yields, has been the motivating force in selling more effective and more complete production and conservation measures to our farmers.

Tests of a Plywood Grain Bin

By L. W. Neubauer
MEMBER A.S.A.E.

THE SMALL prefabricated grain bin constructed and tested for the project reported in this paper has a capacity of 400 bu and is built of standard panels of Douglas Fir plyscord plywood. It is easily assembled or demounted, with no loss or waste of material.

The objective was to develop a small, quickly assembled bulk ient for poultry-men and others who store or feed small quantities grain bin of reasonable cost, which would be suitable and convenof grain. Conferences were held with officials of the Poultry Producers Association of Northern California and others regarding the needs and desirable characteristics for such a storage bin. Plywood used in this construction was furnished by the Douglas Fir Plywood Association, and J. Dewey Long, chief of the Association's research department, cooperated in the planning and experimentation.

A size of 8 ft square and 8 ft high was deemed suitable and convenient, and was easily built of plywood of 4x8-ft panels without waste. Common frame construction was used for each prefabricated section with the usual floor joists and vertical studs in the walls to which plywood was fastened with 6d nails every 3 or 4 in. Plyscord, which is water-resistant, was used instead of waterproof exterior plywood as this bin was intended for use within a flat warehouse or other building which would protect the bin from rainfall. The bin was also constructed without a roof for the same reason. The final plan, however, shows alternate construction and roof of exterior type waterproof plywood for bins to be exposed to the weather.

Plywood was nailed to the outer edges of the studs to make the best use of common sizes of materials and to maintain the greatest capacity possible. With plywood nailed to the interior of the studs, the capacity would be reduced by nearly 100 bu, the appearance less attractive, and all studs exposed to the weather. Fewer nails could be used, however, with no serious loss in strength.

The floor was made of ⅜-in plywood with surface grain perpendicular to the joists. There are nine joists, 2x6 in x7 ft-8½ in, spaced 12 in on centers, and two headers, 2x6 in x8 ft-0 in. Skids were not used under the joists as the bin was not to be moved after assembly and was to be located on the floor within an old building. Normally for outdoor use two skids, 6x6 in x9 ft-0 in, are required as shown on the final plan.

Walls are of varying construction in order to compare results with different stud conditions and plywood size. Quarter-inch plywood is often considered inadequate for grain bin walls, but was tried in this construction for comparison with ⅜-in material.

Wall A was built of two ¼-in plyscord panels, vertical, on seven 2x4 in x7 ft-8⅜-in studs on 12-in centers. Corner posts are 2x4 in flat for bolting or doweling to adjacent wall sections. The 1x4 in x8 ft-0 in sole was mitered at each end and nailed to studs. In assembling it was fastened to the floor and edge joist with eight ⅜x2½-in lagscrews. The plate is 2x4 in x8 ft-0 in with mitered ends for fitting to adjacent panel plates.

Wall B is ⅜-in horizontal plyscord on four 2x6 in x7 ft-8⅜-in studs 18 in o.c., and two 2x4 in x7 ft-8⅜-in posts. The sole is 1x6 in x8 ft-0 in mitered, nailed to studs and secured to floor and header with eight ⅜x2½-in lagscrews. A 2x6 in x8 ft-0-in mitered plate is used. Short 2x4-in horizontal nailing girts were also used between studs for nailing butting edges of the plywood panels. This wall also contains a 16x30-in door and louvers with a small spout for convenience in emptying.

Vertical plywood, ⅜-in thick, was used for wall C, nailed to five 2x6 in x 7 ft-7½-in studs 16 in o.c., and two 2x4-in posts, flat, at ends of wall. A 2x6 in 8 ft-0 in mitered sole was nailed to studs and posts and later anchored to floor and joist with twelve ½-in hardwood dowels. Plate is 2x6 in x8 ft-0 in mitered and nailed to studs.

Wall D is composed of two sections. The upper section is of ¼-in plyscord, horizontal, nailed to seven 2x4 in x 3 ft-8½-in studs 16 in o.c., a 2x6 in x 7 ft-8½-in header, and a 2x4 in x 8 ft-0 in mi ered plate. The lower section is ⅜-in plywood, horizontol, on seven 2x4 in x3 ft-7½-in studs 16 in o.c., a 2x6 in x7 ft-8½-in header, and a 2x4 inx8 ft-0-in mitered sole secured to floor and floor header with twelve ½-in hardwood dowels. In assembling, adjacent headers of upper and lower section were connected with six ½-in hardwood dowels 16 in on centers.

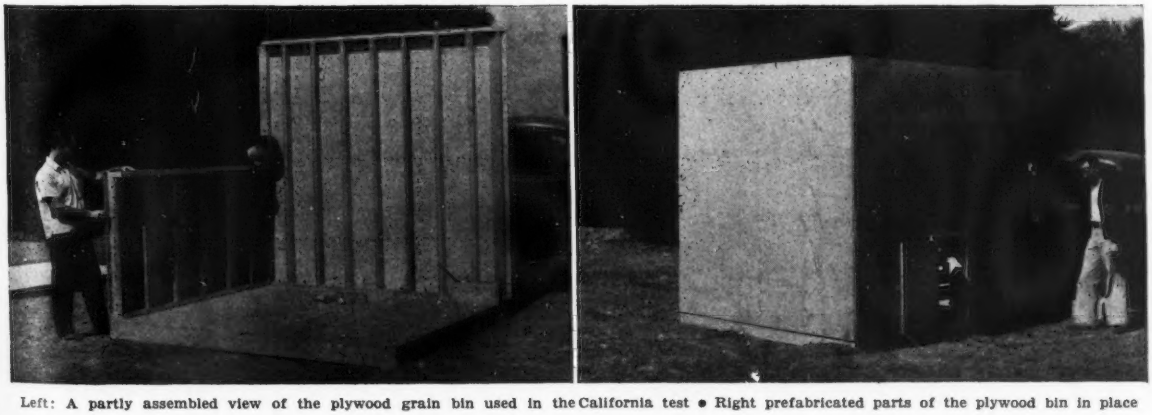
When setting up this bin each wall section was erected in place on the floor panel, anchored to the floor, and a different corner attachment used for each of the four. In this way it was hoped to detect and eliminate any corner tie which might prove unsatisfactory.

Corner D-A utilized eight ⅜x4-in lagscrews, 12 in o.c., to fasten the 2x4-in posts of adjacent wall panels. Corner A-B had, in addition, a 2x2-in corner post which was fastened to each 2x4-in post with eight ⅜x4½-in lagscrews, 12 in o.c., at right angles with each other. Corner B-C was similar to A-B, but utilized nine ½-in hardwood dowels set diagonally through the two 2x4-in corner posts.

At the top of the bin, one 1x6-in x 8 ft-0-in crosstie was used across the center in each direction. These were computed as sufficient to resist the lateral pressures developed there.

Each corner, also, was tied together at the top by means of a 1x6x24-in board with ends cut at 45 deg placed diagonally across the corner and held to the plates of adjacent sidewalls by three ¼x3½-in machine bolts at each end. When a roof is to be constructed on this bin, the corner braces should be placed on the lower face of each plate. No diagonal braces were needed within the wall surface areas as the stiffness of the plywood panels was

Article prepared especially for AGRICULTURAL ENGINEERING. Author: Assistant professor of agricultural engineering, University of California.



Left: A partly assembled view of the plywood grain bin used in the California test • Right prefabricated parts of the plywood bin in place

more than necessary to provide the required strength and rigidity.

Prefabrication of this bin required about four days for two men inexperienced as carpenters. At $6.00 per day, this cost would be $48.00 for labor. More experienced men should easily do the work in three days with labor costing $36.00. Two or three men can assemble the bin in a couple of hours. Framing lumber, nails, and bolts cost between $25.00 and $30.00. The plywood was donated by the Douglas Fir Plywood Association, but if purchased in the usual way would have cost about 6c per sq ft, or $19.20. The total cost then is between $80.00 and $97.20, and the unit cost per bushel between 20 and 25c.

In order to test the strength of this bin, it was filled with wheat, one of the heavier grains. Observations were made and deflections recorded when the bin was half full, as well as when completely filled. To fill the bin 191 bags of wheat, averaging 132 lb per bag, were required, making a total weight of 12.6 tons. Final deflections were observed 64 hr after filling the bin.

Corner C-D with diagonal dowels failed when the bin was half full. This type of corner was used with some hesitation as it was expected to be weak, but was known to have been used occasionally in boxes and other wooden containers. Apparently the lateral pressures on the two sides concerned developed a resultant force placing the dowels in direct tension which opened the corner joint, as the snug fit of the dowels offered only slight resistance. Gluing of these pins would have multiplied the strength many times, but the principle was judged unsatisfactory and lagscrews as in corner D-A were used to replace these dowels resulting in a joint of satisfactory strength. It should be added that the weakness in this section was probably due also to the fact that side D consisted of two 4x8-ft horizontal panels lacking stiffness in the joint between headers and thus being without continuity of vertical studding. There was little strength from top to bottom and lateral pressures were held only by the corner joints. At corner D-A, however, where lagscrews were used, there was no sign of failure.

All other corners and joints maintained their positions with no evident weakness. There was no apparent crushing of the dowel fastenings and no visible movement of lagscrews or bolts.

Plywood deflected only small amounts between studs. The ¼-in panels on 12-in spans showed a maximum of about ⅛ in. The ⅜-in vertical plywood on 16-in spans deflected 3/16-in between studs. With the ⅜-in plyscord horizontal no deflections were visible. This fine display of stiffness was considered superfluous and uneconomical, so the ¼-in thickness on 2x4-in studs at 12-in centers (side A) was chosen to be shown on the final plan.

Corner D-A having the simplest satisfactory fastening was selected for the new plan. Eight lagscrews were required. An alternate corner attachment is also suggested, utilizing nine ½-in dowels in each direction, as in test corner B-C. This is recommended when iron lagscrews are not available. Plan C-531 of the University of California at Davis shows all details for the final assembly.

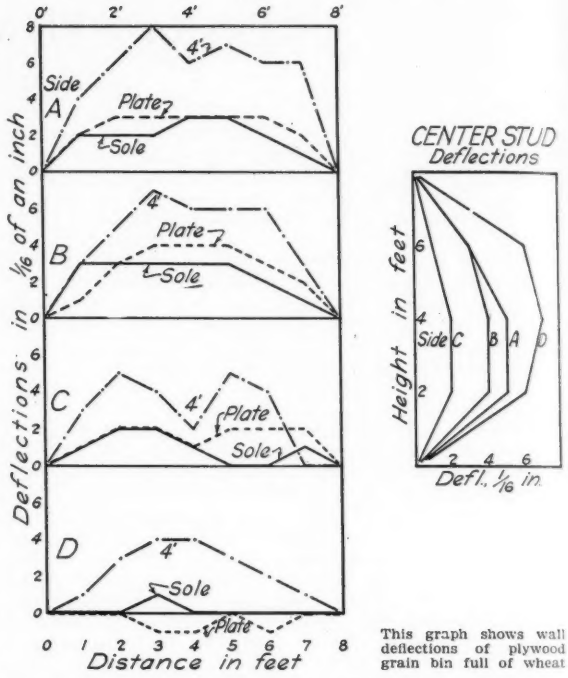
TABLE 1. GRAIN BIN WALL DEFLECTIONS, 1/16 IN

	Distance in feet							
	1	2	3	4	5	6	7	Average
Side A Plate	2	3	3	3	3	3	2	.170 in
4 ft	4	6	8	6	7	6	6	.385 in
Sole	2	2	2	3	3	2	1	.134 in
Side B Plate	1	3	4	4	4	3	2	.188 in
4 ft	3	5	7	6	6	6	3	.322 in
Sole	3	3	3	3	3	2	1	.161 in
Side C Plate	1	2	2	1	2	2	2	.107 in
4 ft	3	5	4	2	5	4	0	.206 in
Sole	1	2	2	1	0	0	1	.062 in
Side D Plate	0	0	-1	-1	0	-1	0	-.027 in
4 ft	1	3	4	4	3	2	1	.161 in
Sole	0	0	1	0	0	0	0	.009 in
Average Plate								.1096 in
4 ft								.2683 in
Sole								.0916 in

CENTER STUD DEFLECTION

Height, feet	Side A	B	C	D	Average
6	3	3	1	6	
4	5	4	2	7	
2	5	4	2	6	
Average	.271 in	.229	.104	.395	.250 in

Observed deflections are given in Table 1. Only the final readings are shown as the intermediate readings provide no additional information. They were taken at 1/16-in increments 1 ft apart along each sole, plate, and at midheight. Readings were also taken at 2-ft intervals from top to bottom of studs at the center line of each wall panel.



This graph shows wall deflections of plywood grain bin full of wheat

From these data, points have been plotted in the accompanying graph to show the trend of results which will be discussed along with the tabular data.

As might be expected, stiffness of the sidewalls varied in the order of walls C, B, A, D. This is natural because of the size and spacing of studs as described above. An ambiguity in the results for side D might be detected because of the small horizontal deflections as compared to the center stud readings. This is explained, however, in the reminder that the corner weakness and use of two horizontal panels resulted in large "center stud" figures; the small wall deflections are not as favorable as they might appear, as intermediate deflections were measured from corner bases which had also moved. The negative readings along the plate must be explained in the warping of the upper panel due to the pressure at the 4-ft height together with a force from the lower panel and relatively low pressures near the plate. Readings along the sole are very small because it acts as a single unit anchored at ends and to the floor again with a tendency toward warping.

Following this 64-hr test, the bin was dismantled and moved to an exterior location having favorable light where moving pictures and still photographs were taken showing stages in the assembly of the bin.

Later the bin was again assembled and filled with rolled barley weighing 33 lb per bu, and having a total weight of about 6½ tons. This load and resulting lateral pressures are apparently not critical, as after a few months of settlement the barley had no noticeable effect upon the shape or unity of the structure.

Results of this experiment were considered wholly satisfactory. In summarizing, a few suggestions are offered:

1 Diagonal dowels are not satisfactory for corner fastenings.
2 Perpendicular dowels as well as lagscrews can be used at corners.
3 One-fourth-inch plywood is adequately strong for wall material on this size of bin, when spanning 2x4-in studs on 12-in centers.
4 Studding can also be 2x6-in material at 12 to 18-in centers, but may require thicker plywood resulting in heavier panels more difficult to handle.
5 Soles of 2-in material are strongly recommended in place of 1-in boards.

Dyhydration of Sweet Potatoes for Livestock Feed

By Ray Crow
MEMBER A.S.A.E.

THE SWEET potato is native to the tropical and semitropical areas, and while it is grown as a truck crop as far north as central New Jersey prolific yields in the United States are generally confined to the vicinity of the south Atlantic and Gulf states. The sandy soils and long growing season of this section appear well suited to its cultivation and production.

This tuber belongs to the same vegetable family as the morning glory. Due to this fact, Dr. Julian Miller, horticulturist at Louisiana State University, undertook the task of inducing the plants to flower and produce seed. He succeeded in this effort to an extent that for some years now he has been developing and fixing new strains and varieties from seedlings, on a considerable scale, by means of crosspollinization. Already Dr. Miller has brouht out several improved varieties for specific purposes, but feels that his work along this line is just beginning.

There are two general kinds of sweet potato, the yellow, or so-called Puerto Rican, and the white, of which the Triumph is a representative variety. The color of the first is given by the carotene content, and it is slightly higher in sugar value. For these reasons, the yellow sweet potato is considered superior for food purposes and is generally grown for the table market. The white varieties are higher in starch content and much more prolific. Yields of 800 bu or more than 20 tons per acre have been recorded on occasion. It is this white variety that has been used experimentally and commercially as a source of starch and livestock feed.

In chemical composition the solids of the sweet potatoes form a carbohydrate closely akin to that of corn, and exhaustive feeding tests have shown them to be fully equal as a fattening and finishing feed for livestock. Unlike the cereals, however, sweet potatoes do not mature in the sense of ripening. They continue to grow until arrested by some radical change in environment such as serious drought, cold weather, or some form of decay sets in. Thus the roots contain 60 to 70 per cent moisture content, depending on variety, at all times and practically none of this can be extracted from the whole potato by any known natural means. However, they can be stored for several months after harvest without serious loss from decay if placed in correct and carefully maintained conditions of temperature and humidity.

It is evident then that if the sweet potato is to become a dependable, convenient, year-round source of carbohydrate stock feed, it must be dehydrated to a safe-keeping moisture content. Experience has shown this to be about 12 per cent or practically the same as that of the cereals. This means that even from those varieties that contain as little as 60 per cent moisture, such as the L-45 recently developed and fixed by Dr. Miller, 2,400 lb of moisture must be extracted from 4,400 lb of green potatoes to secure 1 ton of dry feed. In this connection, it may be of interest to note another example of the potential commercial importance of plant breeding. Previous to the development of the new strains by Dr. Miller, the lowest moisture content of any variety known as approximately 70 per cent of the green weight. By developing a variety containing only 60 per cent moisture, Dr. Miller already has reduced the amount of water to be evaporated per ton of dry feed from 3,780 lb to the 2,400 lb mentioned, or 38 per cent, and is confident of further reduction. One of his new strains shows a moisture content of only 56 per cent, but as yet its other characteristics have not been definitely determined. Even this moisture content, if fixed, would reduce necessary dehydration by another 400 lb per ton of dry matter.

The preliminary operation toward dehydration of sweet potatoes, naturally, is that of cleaning. This is done either by washing or brushing, or a combination, in a way similar to that performed on root and vegetable crops in preparing them for marketing, canning, or other commercial purposes. Since sweet potatoes are usually grown in friable sandy soils, satisfactory cleaning is not difficult. Short immersion in water followed by the application of a clean spray under light pressure is usually sufficient.

The next operation is that of slicing, shredding, or pulping, the raw potato in order that heat may be applied to smaller particles or sections. Generally speaking, if a mechanical press is to be used to extract a part of the moisture before drying, the raw potatoes are passed through a hammer mill and thoroughly pulped. If complete extraction of moisture is to be by drying, they are either sliced or cut into strings approximately 3/16 in square, commonly called shredding. The machine most generally used for this purpose at present was developed in detail by Fred A. Kummer, agricultural engineer at Alabama Polytechnic Institute, based on pioneer work done by Dr. W. O. Gordon and J. W. Randolph of the U. S. Department of Agriculture, at Laurel, Miss. This machine consists of three standard beet shredding knives mounted on a horizontal circular rotating steel plate 20 in in diameter located at the bottom of a cylindrical hopper. The weight of the potatoes in the hopper keeps a constant pressure feed against the rotating knives and the strings pass through slits in the plate to a receptacle or conveyor beneath.

The rear-end assembly of a junked automobile supplies the gearing, and a steel oil drum with heads removed, or a similar cylinder, becomes a hopper. The cost of such a machine, built in accordance with the carefully detailed plans that Professor Kummer has worked out, is nominal. It can be fabricated in any ordinary machine shop, or even in a well-equipped farm shop, and will shred up to 300 bu of raw potatoes per hour. It is estimated that approximately 150 of these machines have been built for use this (1942) season, mostly by gathering up and assembling secondhand items, since new material for the purpose was not available.

The first commercial operation for mechanical dehydration of sweet potatoes was installed at the USDA Laurel, Miss., starch plant. This was to dry the waste pulp that remained after extraction of starch. Since this material already was pulped and contained considerable excess moisture, a press was installed to reduce this to about 60 per cent. The material was then dried in a steam coil heated rotary-type kiln. Shortly after this development, The Warriner Starch Company of St. Francisville, La., began commercial production of stock feed from the whole potato. This concern, as the name implies, had been interested in extracting starch from sweet potatoes, but had been largely inactive in this line for some years. Inasmuch as its equipment was suited for pulping and pressing, the same general method was followed as that at Laurel.

Probably both operations were influenced toward this method by the fact that in practically all cases where dehydrated stock feed is produced from spent grains at distilleries, beet pulp at sugar refineries, citrus pulp from juice canning plants and from other waster products, the material is pressed before drying. However, such material is usually high in moisture content, running to 95 per cent or even more. In many cases the product after pressing carries as much moisture as does the raw sweet potato. Also, there is considerable loss of solids carried away in the press water, which it is both difficult and expensive to reclaim. The product of this type of operation is in the form of a coarse meal mixed with considerable fines and some larger particles. The installation cost of a plant of this type, with a capacity of one to two tons of dried feed per hour, runs from $50,000 to $75,000 when steam coil drying units are used, but somewhat less with direct heat dryers.

In the meantime, experiments had been continued at the federal laboratory at Laurel and at various agricultural experiment stations, looking toward developing lower cost methods. Officials of my company became interested and authorized me to offer assistance in any way that it could be of value. An opportunity soon arose. Officials of the state of Alabama became interested in the installation of a commercial size plant on one of its prison farms located near Atmore, Ala. However, they did not feel justified in expending the amount of money indicated above. I was asked to

Paper presented at the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1942. Author: Agricultural engineer, Tennessee Coal, Iron & Railroad Co.

assist the chief engineer of the state prison system, and we made a rather detailed study of all the information then available, including visits to a number of drying plants operating on various products. Neither of us knew anything about dehydration to begin with except that it consisted of driving moisture from materials by the application of heat. Therefore, we could compare the merits of the various conflicting arguments put forth in favor of, and in opposition to, the use of specific methods and types of equipment without preconceived prejudice. We gained the impression from this study that possibly the field of dehydration, particularly as it pertained to the subject of sweet potatoes, had not yet been fully explored.

The result was that we recommended the purchase of a second-hand rotary kiln 5 ft 6 in in diameter by 60 ft long that previously had been used for drying Fuller's earth. The furnace was equipped with fuel oil burners and arranged for the products of combustion to pass directly through the material. This plant was moved to the prison farm and installed with some changes made in the set-up. The drum was set level instead of on an incline as before and the direction of the feed changed to flow with instead of counter to the hot air current. A shredder was improvised from an old kraut cutter, some second-hand motors were purchased, and an exhaust fan installed to secure draft instead of the stack originally used. Some new elevating and conveying equipment was put in.

OPERATION OF DEHYDRATION PLANT PROVED SO SUCCESSFUL THAT PLANTING OF SWEET POTATOES WAS INCREASED

You may be sure that we wondered a great deal during the construction whether or not it would run. But it did. From October 15, last year, until some time in January this equipment dehydrated 70,000 bu of sweet potatoes, producing feed equivalent to approximately 25,000 bu of shelled corn. Incidentally, these potatoes were produced as a second crop, being planted following the digging of an early crop of Irish potatoes. Even so, the yield was 275 bu per acre, equivalent to nearly 100 bu of corn. The operation of this plant was considered so successful and the product filled such a need at the prison farm that a much larger planting of sweet potatoes for the purpose was made this year and the plant is again operating steadily. The product when dried in this manner, without the use of a press, is in the form of cosettes, somewhat similar in appearance to fried, shoestring potatoes and very little dust develops.

Neither the installation nor the operating cost of this plant would be a guide for commercial installation. The labor was all done by prisoners and no charge was entered for that item. Some of the equipment and material used was already on hand and the state operates a fairly well equipped machine shop in which much of the fabrication and assembly work was carried out. However, estimates made during the installation indicate that a plant with a similar capacity of 1 to 1½ tons of dry feed per hour, designed on the basis of our present knowledge and fabricated from new material throughout on a commercial basis, would cost somewhere in the neighborhood of $15,000, including buildings. This is based on 1941 prices of labor and materials.

But even $15,000 is a considerable outlay and a plant of this capacity would require the production of 800 to 1200 acres for a season's operation. Therefore, we designed and my company subsidized the fabrication, as a trial unit, of a semiportable practically self-contained plant with an estimated capacity of 300 lb or more of dry feed per hour. It is a rotary kiln type, using oil or natural gas for fuel, and has a shredder mounted on the frame. It was so designed that one 8 to 10-hp unit drove all operations. The machine readily can be fabricated in any reasonably well equipped machine shop at a cost of $1500, or less, at 1941 prices.

This trial unit was not completed in time for extended operating tests last season. It was given a brief run, however, and produced an excellent product. For the current season it was turned over to the agricultural engineering department of the Alabama Polytechnic Institute at Auburn for further tests as to efficiency. The results indicated that some changes in the original design were desirable. The plans were revised accordingly. Furthermore, the WPB has now approved the allocation of steel for the fabrication of the plants under certain conditions. A considerable number of them probably will be fabricated for the 1943 season.

Inability to obtain steel for the fabrication of new plants gave impetus this season to the modification of dehydrating equipment originally constructed for other purposes. Just how far this has gone we do not know, but several of the 150 shredders mentioned were constructed for use with such set-ups. Equipment suitable for drying sugar, sand, cotton, hay, shrimp, and many other items can be used with some modification and the addition of cleaning and shredding machinery. The survey of the results of all the plants operating this season will be started soon to assemble data looking toward further improvement in design and methods.

Some time during the development of this interest in sweet potato dehydration, Prof. L. M. Ware, horticulturist at Alabama Polytechnic Institute, conceived the idea that the shredded tubers could be dried satisfactorily by simply exposing them to sun and air. Furthermore, he proceeded to prove the soundness of this conclusion on a sizeable scale during the 1941 season. Detailed results of his work are given in his bulletin, entitled "Drying Sweet Potatoes". Briefly, the method consists of spreading the shreds or strings in a layer on a waterproof, dustless surface in the open air until dried to a safe-keeping moisture content. On a sunshiny day, particularly if a breeze is blowing, 8 to 10 hr of such exposure is ample. Cloudy, humid weather, of course increases the necessary time of exposure, but even in rainy weather, if showers are not too long or continuous, the material eventually will dry without decay or serious injury.

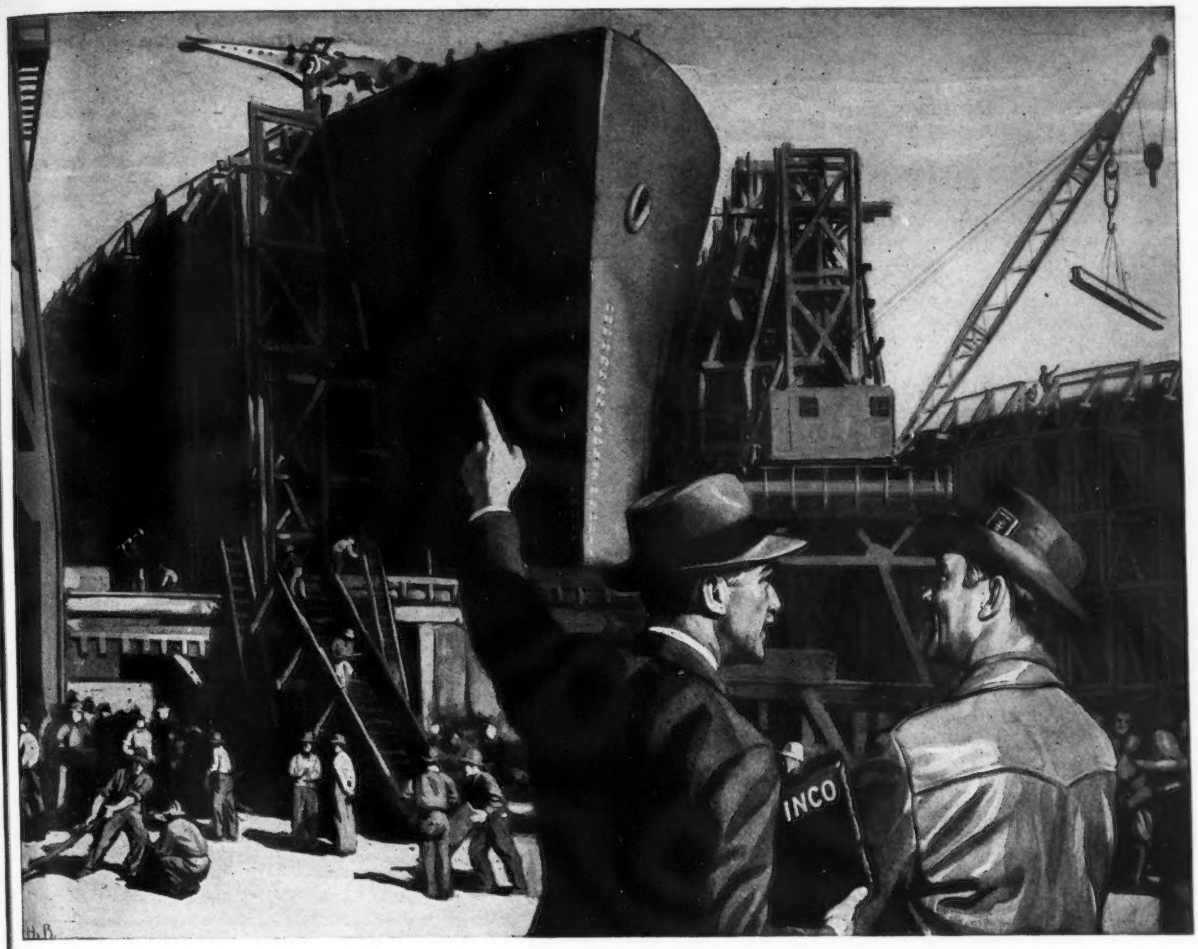
BOTH AIR DRYING AND MECHANICAL DRYING OF SWEET POTATOES WILL PROBABLY HAVE THEIR PLACE

Professor Ware tested the merits of several types of surfaces. Among these were various kinds of building paper, composition roll, and steel sheet roofings and asphalt or oil stabilized earth. He found but little difference in the exposure time required; therefore, the choice is a matter of amortized cost. Over a period of years the permanent paving type is probably more economical but prohibits use of the ground for crop growing purposes in off-seasons. However, probably it would be useful for other purposes in connection with the farmstead operation. The other surfaces tested are portable and if not worn out during the season can be stored for future use. In any case, the annual cost of the surfacing material per ton of dried product is extremely small.

The installation cost of this method of drying is much less per ton capacity than that of any present known method of mechanical drying. Also, the fuel cost is eliminated. So far detailed information is not at hand by which to make a valid comparative analysis of labor costs and other factors involved in the two methods under various conditions. Probably both methods will have places in the picture. It may be that air drying will be found economical on individual farms or in small community operations where local labor is plentiful, while mechanical operations will be indicated in commercial plants.

The foregoing is a brief resume of what we have done in developing a new use for an old crop, also in the substitution of a crop that we can grow easily and prolifically for one that we have grown with difficulty, sparsely, and unprofitably since agriculture was established in the South. Measured in terms of the apparent potentiality involved, our progress so far is rather negligible. However, we have reason to believe that had steel not "gone to war", mechanical dehydration of sweet potatoes would have become something of a factor in this season's Southern agriculture. As it is, we know that nearly all of the 150 shredders built during the spring and summer were for the purpose of preparing sweet potatoes for the simpler and less expensive method of sun and air drying and, probably will be so continued for the duration. To what extent this method will prevail in the postwar period after materials for fabricating mechanical plants become again available remains to be seen. But that is immaterial from the standpoint of our overall agricultural need — a dependable, prolific carbohydrate livestock feed.

There is no thought that this product will become a feed factor in the national markets. It is hoped, however, that we can thus grow sufficient fattening and finishing livestock feed to supply all of our own consuming needs of livestock and its products on one-third of the 17 million acres of land now producing corn with average yields of 12 to 15 bu per acre, the total of which is sufficient for only 60 per cent of those needs. To this end we are working.



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A. S. A. E. War Service Honor Roll

APPROXIMATELY 18 per cent of the members of the American Society of Agricultural Engineers are now on active duty with the armed forces of the United States and its United Nations allies. Listed here are the names of those active members of the Society who are definetely known to be in war service, according to records at A.S.A.E. headquarters. However, the list is probably not complete, and it is of course constantly growing. This list will be published from time to time in AGRICULTURAL ENGINEERING, and the Society will welcome information covering (1) additions to the list, (2) promotions in rank, (3) changes or corrections in branch of service, etc. Such information should be reported promptly to Secretary A.S.A.E., St. Joseph, Michigan.

M. S. Adams, Capt., 2-D-5th Defense Battalion, USA
William M. Adams, A/C, Air Force, USA
Chester O. Anderson, Lt., Corps of Engineers, USA
Donald A. Anderson, Capt., Ordnance Dept., USA
John M. Anderson, Lt., Field Artillery, USA
Quincy C. Ayres, Com., liaison officer, design division, Bureau of Yards and Docks, USN
J. M. Babb, 1st Lt., Quartermaster Corps, USA
Thomas L. Baggette, Maj., 114th Field Artillery Bn., USA
Ralph W. Baird, Capt., 605th Coast Artillery (antiaircraft), USA
Harry R. Ball, Lt. (j.g.), Parachute Officer, USNR
Juan Bazo-Fontaneil, Pvt., Air Force, USA
James E. Beamish, Lt., Royal Canadian Engineers
Hatto M. Berg, 2nd Lt., 113th Observation Sqdn., Air Force, USA
Clarence J. Bergschneider, Pvt.., 803rd Ordnance Co., USA
H. E. Bergschneider, Capt., 341st Naval Trgn. Sqdn., Air Force, USA
Harry E. Besley, Lt. Col., Corps of Engineers, USA
Dale L. Bidwell, Ensign, USNR
J. Reid Bishop, Lt. (j.g.), USNR
J. T. Blakely, Lt., 437th C. A. Bn., USA
Clarence W. Bockhop, USA
L. W. Bonhorst, Apprentice Seaman, USNR
C. R. Boone, Pvt., Officer Candidate School, USA
James S. Boyd, Ensign, USNR
Clint W. Bracher, 1st Lt., Field Artillery, USA
Eugene C. Buie, Capt., 55th Quartermaster Regiment (heavy motor maintenance), USA
B. Gwynne Burr, 1st Lt., 17th Troop Carrier Sqdn., USA
John C. Bursik, Ensign, USN
G. A. Burson, Jr., Lt., 11th A. R., 10th Div., USA
Clarence J. Bush, 2nd Lt., Field Artillery, USA
Elwin D. Butler, 2nd Lt., 156th Inf., USA
Harold C. Campbell, 1st Lt., Air Force, USA
R. Barry Cecil, 1st Lt., Air Force, USA
Frederick C. Chambers, Capt., Ordnance Dept., USA
Thayer Cleaver, Capt., Coast Artillery (antiaircraft), USA
Kermit R. Cline, 1st Lt., Coast Artillery (AA), USA
Lawrence Collins, Maj., G.S.C., Hdq. 2nd Armored Div., USA
Stanley A. Collins, Capt., Corps of Engineers, USA
Edward O. Cone, 2nd Lt., Corps of Engineers, USA
William A. Cornwell, Ensign, Sqdn. 8-B, Air Forces, USNR
Wansley H. Cox, 1st Lt., 130th Infantry, USA
Fred M. Crawford, Capt., 75th Coast Artillery (antiaircraft), USA
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Myron G. Cropsey, Maj., Ordnance Dept., USA
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Russell S. Danio, Pfc., 68th Troop Carrier Sqdn., Air Force, USA
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Paul C. Dillon, Capt., 82nd Field Artillery, USA
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Donald L. DuBois, Lt.(j.g.), USNR
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W. McNab Miller, Sgt., 35th Tech. School Sqdn., Air Force, USA
Arthur W. Milliken, Lt. USN
Edwin T. Mims, A/C, Air Force, USA
S. T. Moore, Jr., 1st Lt., Air Force, USA

FOOD—and the Farm Equipment SHORTAGE

A Report to the Farmer:

WE HAVE learned with surprise that in some parts of the country farm equipment manufacturers are being charged with responsibility for the inadequate supply of farm equipment now available.

The statement has been made that farm equipment manufacturers are more interested in producing war materials than in producing farm equipment.

Certainly our industry is interested in producing war materials. No one would want us to be otherwise. But we have never forgotten that to enable the farmer to meet wartime food production goals we must build farm equipment, and we have constantly urged upon the government the need for greater amounts of farm equipment, a view which has now been acknowledged to be correct. Our operations, with respect to both war production and farm equipment production, have at all times been governed by the decisions and actions of the government.

The statement has also been made that our industry cannot make enough farm equipment because its plants have been converted too largely to war production.

It is true that International Harvester Company is engaged on a very large program of war production, but it is *also* true that we have always had facilities available for the production of farm equipment.

We want farmers and the public generally to understand the facts about the farm machinery situation, which is of vital importance in determining whether the United States can do the food production job.

1. What is Necessary to Supply Farm Machines?

To supply farm machines and replacement parts today, a manufacturer must have five things: First, plants and facilities; second, men and women to operate the plants; third, authority from the government to build a certain amount of machinery and replacement parts; fourth, materials out of which to make the machinery and replacement parts; fifth, an adequate system for timely distribution of these products.

Our company and other farm equipment manufacturers have the plants and facilities. We have, or can speedily train, the men and women needed. We have a large and capable distribution organization which, left to itself, can do the job properly. *But both authority to manufacture and materials for manufacture can be provided* ONLY *by the government. And at present the distribution of farm machinery is also completely controlled by the government.*

The government has never asked us to convert all our facilities to war work and we have never considered doing so. The government knew, and we knew, that farm equipment production, up to some limit, would prove as vital to the war effort as production of guns and shells. Throughout the war, our farm equipment factories have continued to produce new farm machines in the limited amounts allowed by the government, and we have regularly produced a large volume of replacement parts, which are made on the same equipment and by the same employes as parts which are assembled into completed farm machines.

Our war work is largely of a kind which requires the automotive type of buildings and facilities and is being carried on principally in our plants of that nature. War work also has been placed in a number of the large warehouses which are characteristic of the farm equipment business. Although most of our farm equipment manufacturing capacity is not adaptable to war production, we do have some war production in every plant of the company.

For all these reasons, the great bulk of our farm equipment production facilities is available now and has been available at all times throughout the war. Those facilities are capable of turning out many times the amounts they are now producing.

2. Can More Machines Be Built in Time for 1943 Use?

The War Production Board's 1943 farm equipment program, which provided for production of only 23 per cent of the amount of new farm equipment that had been built in 1940, was too small to meet farmers' needs. This has now been publicly recognized by official Washington, and the government has recently announced that it was granting authority for increased 1943 production of some farm machines. This recognition, however, comes too late in this year for the situation to be more than partially corrected.

Included on the government's list of increased machines were such items as tractors, which are useful at any season of the year, and harvesting machinery, which in most sections of the country and for most crops is used relatively late in the year. Production of these machines can still be increased in time to help in 1943.

But production cannot be increased overnight and this authority to manufacture will be useless unless it is accompanied at once by the necessary materials.

Undoubtedly many farmers—and probably some county rationing committees—have expected increased numbers of machines to appear immediately after government announcements of increased authority to manufacture. It must be remembered that after authority has been granted, from 60 to 120 days are required to get steel and other materials, time is required to turn these materials into finished machines, and additional time is required to get them to the places where the government orders the manufacturer to send them. Most farm machines cannot be shipped by the manufacturer until they have been tagged by order of the Department of Agriculture for the particular county of the United States where the government has decided they are to go.

The government has recently increased somewhat its allotment of steel to farm equipment production, but farm machines cannot be built of steel alone. Other critical component parts are required.

If these components are provided at once, the output of tractors and harvesting machinery for 1943 delivery can still be increased.

3. Will There Be Enough Machinery in 1944?

Yes...

IF the government draws up its farm equipment production program for 1944 in accordance with the needs of American farmers, and

IF the government makes that program definite and effective in the immediate future, and

IF distribution down to the retail level is fitted to the needs of the food program and carried on by experienced and tested manufacturers and *retail dealers' service organizations,* in cooperation with the government, and

IF, above all, the government will provide the needed materials regularly and on time,

THEN, the farm equipment industry will certainly build the machines to do the job.

Fowler McCormick
President
INTERNATIONAL HARVESTER COMPANY, CHICAGO, ILLINOIS

INTERNATIONAL HARVESTER

William E. Moore, Jr., Capt., Headquarters Battery, 24th Div. Artillery, USA
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C. K. Otis, Lt. (j.g.), Naval Air Navigation School, USNR
Ralph A. Palmer, Maj., Air Force, USA
Ralph R. Parks, Lt. Col., 199th Ordnance Bn., USA
Robert A. Parmele, 2nd Lt., 37th Armored Regiment, USA
Ben J. Pecena, Pvt., F. H. S. Reception Center, USA
B. E. Pettit, Lt., Hq. 298th Engineers Bn., USA
Thurman P. Powell, 1st Lt., Co. C, 201st Infantry, USA
John W. Propst, Jr., 1st Lt., 31st Engineers Regiment, USA
James B. Putman, 1st Lt., Hdq. E. U. T. C., S-4, USA
Earl J. Rodman, Capt., 13th Infantry, USA
Paul H. Rofkar, Capt., Field Artillery, USA
L. L. Sammet, Lt., Civil Engineering Corps, USA
Charles M. Sanders, 1st Lt., Field Artillery, USA
R. A. Schmidt, Pilot-Officer, Royal Canadian Air Force
Arthur H. Schulz, 2nd Lt., Air Force, USA
W. D. Scoates, A/C, Air Force Technical Trng. Detachment, USA
Hillard C. Seaton, Maj., 382nd Eng. Bn., Armored Forces, USA
Millard R. Seaton, Capt., 8th Mtz. Div., Rcn. Sqdn., USA
James L. Shepherd, Capt., Air Force, USA
Claude B. Solterbeck, 1st Lt., Co. C, 18th Engineers, USA
Jerome W. Sorenson, Jr., Maj., 142nd Infantry, USA
John P. Spielman, A/C, Air Force, USA
James P. Stafford, Jr., 2nd Lt., Corps of Engineers, USA
Herbert N. Stapleton, 1st Lt., Coast Artillery, USA
A. H. Stephenson, 1st Lt., Coast Artillery, USA
Gustavus H. Stewart, Capt., Hdq., 111th Corps, USA
Homer J. Stockwell, Capt., A.A.A.S., USA
Lowell Stoddard, Pvt., Aircraft Mechanic Student, USA
Samuel Strebin, Ensign, USNR
Norris P. Swanson, Ensign, USNR
John G. Taylor, Reserve Corps, USA
L. LeRoy Reaves, Ensign, USNR
Walter H. Redit, Maj., Executive Office, A.C. Section, USA
Wm. O. Ree, Lt. (j.g.), 58th Bn., USNR
Russell H. Reed, Maj., Quartermaster Corps, USA
Thomas L. Reeves, 1st Lt., 839th Engineers Aviation Bn., USA
Bernard D. Reynolds, Jr., 1st Lt., Field Artillery, USA
Charles E. Rice, 1st Lt., 102nd Cavalry (mechanized), USA
Joe B. Richardson, 1st Lt., Coast Artillery (antiaircraft), USA
Herbert S. Riesbol, 1st Lt., Corps of Engineers, USA
June Roberts, Lt., USNR
James B. Robinson, Jr., 1st Lt., (43G), USA
John W. Rockey, Maj., Air Force, USA
Oscar C. Teigen, 1st Lt., Air Corps, USA
H. Raeburn Test, 1st Lt., Air Force, USA
Wm. D. Test, Capt., Co. D, 66th Bn., 14th Regt., USA
Anthony E. Theisen, Pvt., USA
Arthur H. Thompson, A/C, Maintenance Engrs., Air Force, USA
Harold J. Thompson, 2nd Lt., 472nd Engineering Maintenance, Co., USA
L. F. Thompson, 1st Lt., 36th Field Artillery, USA
Donald L. Trapp, A/C 2, Royal Canadian Air Force
James R. Turner, 2nd Lt., Corps of Engineers, USA
Willie L. Ulich, 2nd Lt., Quartermaster Corps, USA
Robert H. Vahrenkamp, 1st Lt., Hdq., Southern Defense Command, USA
Richard L. Walker, Capt., Air Force, USA
H. B. Wall, 2nd Lt., 6th Cavalry, USA
J. Arthur Weber, Pvt., Engr. Replacement Trng. Center, USA
Wm. A. Weld, Capt., Corps of Engineers, USA
William, C. Wheeler, 1st Lt., 329th Infantry, USA
Lowell L. Whitaker, Lt. (j.g.), USNR
Richard N. White, 1st Lt., Air Force, USA
Donald C. Wiggins, Ensign, Civil Engineers Corps, USNR
John W. Wolfe, 1st Lt., 32nd Infantry, USA
Wm. S. Woods, Pvt., 24th C.T.D., USA
O. C. Word, Jr., Lt. Col., Infantry, USA
J. R. W. Young, S/Lt., Royal Canadian Navy

Gold Star Members

Lt. Samuel J. Baldwin — January 13, 1943
Lt. John E. Cottingham — January 27, 1943
Lt. James E. McCay — January 28, 1943

NEWS SECTION

A.S.A.E. Meetings Calendar

June 21 to 23—Annual Meeting, Purdue University, Lafayette, Ind.

December 6 to 8—Fall Meeting, La Salle Hotel, Chicago, Ill.

Ag Engineers Day at Beltsville

WITH AN attendance between 60 and 75, most of whom were members of the American Society of Agricultural Engineers, the field day at the Beltsville (Md.) Research Center on May 21st, sponsored by the Washington (D.C.) Section of the Society proved an interesting and profitable event. In addition to members and friends of the Society in Washington and vicinity, several members came from some distance to participate in the tour of the Research Center.

During the luncheon hour the group was addressed by Dr. Robert M. Salter, chief of the USDA Bureau of Plant Industry, Soils, and Agricultural Engineering, to which bureau some phases of the work in agricultural engineering were recently transferred.

During a short business session held during the day, new officers of the Washington Section were elected as follows: *Chairman,* George Krieger, director, farm machinery branch, War Production Board; *Vice-chairman,* C. L. Hamilton, agricultural engineer; and *Secretary-Treasurer,* N. R. Bear, chief, division of organization and personnel management, Office of Personnel, USDA.

A.S.A.E. Members in War Service

IN ADDITION to the large list of members of the American Society of Agricultural Engineers in the armed services, published in this issue, several members of the Society are serving in wartime administrative agencies of the federal government in Washington. While the following list does not contain the names of all these members, and while their connections may not be entirely accurate as given, it is believed to be reasonably complete, and the editor will of course welcome additions and corrections:

George Krieger, director, Farm Machinery and Equipment Division, War Production Board.

W. F. Heesch, deputy director, Farm Machinery and Equipment Division, War Production Board.

H. S. Pringle, chief, maintenance, repair, and used equipment branch, Farm Machinery and Equipment Division, War Production Board.

C. D. Kinsman, head engineer, Farm Machinery and Equipment Division.

E. L. Arnold, analyst, Farm Machinery and Equipment Division, War Production Board.

H. Lee Vanderwilt, industrial analyst, Farm Machinery and Equipment Division, War Production Board.

R. M. Merrill, consultant, products branch, Conservation Division and Farm Machinery and Equipment Division, War Production Board.

A. W. Lavers, D. A. Milligan, D. C. Heitshu, and *E. G. McKibben,* part-time consultants, Farm Machinery and Equipment Division, War Production Board.

E. J. Hergenroether, assistant chief, metallurgical and conservation branch, Steel Division, War Production Board.

Archie A. Stone, chief, farm equipment and tractor section, Machinery Branch, Office of Price Administration.

Robert C. Burnette, acting section chief, farm machinery and building materials section, Standards Division, Office of Price Administration.

A. P. Yerkes, collaborator, War Food Administration.

E. M. Dieffenbach, farm machinery and supplies division, Office of Materials and Facilities, War Food Administration.

C. L. Hamilton, in charge, farm buildings section, War Food Administration.

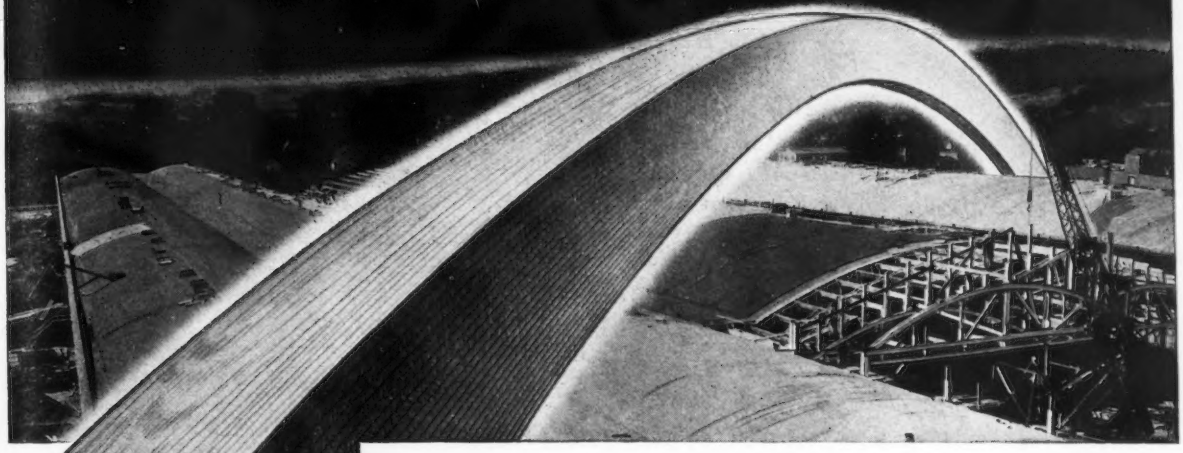
The foregoing is not complete and probably is not entirely accurate. The editor will welcome additions and corrections.

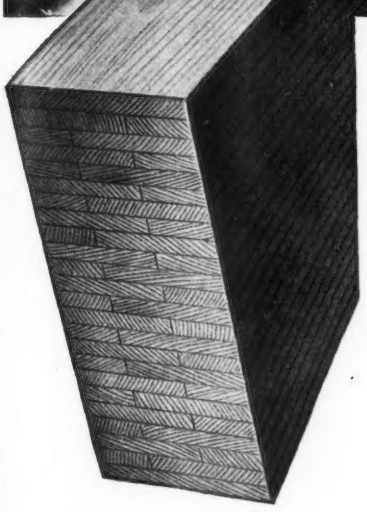
A few A.S.A.E. members who have previously served government wartime agencies have returned to their former business connections.

(News Section continued on page 208)

RILCO *Laminated Wood* BOWSTRING TRUSSES

speed construction of essential building!





FACTORY-FABRICATED WOOD STRUCTURAL MEMBERS

Available for more post war construction of Farm Buildings

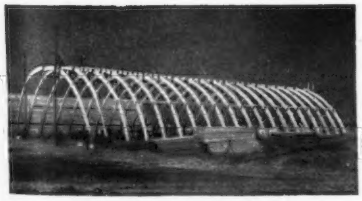
▶ Rilco glued laminated roof arches and other structural framing members are playing a major role in the war time construction of airplane hangars, drill halls, chapels, storage, service and factory buildings.

But long before war needs engaged most of Rilco's production facilities, its laminated rafter arches were serving the needs of agriculture. The large post-free hangar pictured at the lower left, is only a giant extension of the Rilco round roof brooder house. The framing members of both are of glued laminated wood construction.

As structural engineers found not only needed strength and rigidity in the wood arch, but precision and economy as well, so will the farmer discover the same values in Rilco Arch Rafters designed for farm construction. They are engineered for the job requirements as to strength and low cost. They are factory-fabricated and delivered to the local lumber dealer for quick erection at the farm. They save on materials and erection time—assure strong, rigid, more wind-resistant structures.

Rilco will gladly mail you on request, illustrated literature on the design and manufacture of glued laminated framing members and a special folder on farm buildings.

Copyright 1943, R. L. P., Inc.



RILCO

DESIGNERS AND FABRICATORS OF ENGINEERED WOOD PRODUCTS FOR A WIDE VARIETY OF USES

RILCO LAMINATED PRODUCTS, INC.

A Weyerhaeuser Institution

GENERAL OFFICES: FIRST NATIONAL BANK BUILDING, SAINT PAUL, MINNESOTA

Eastern Division—221 Conyngham Ave., Wilkes Barre, Pennsylvania; *Southern Division*—3200 Grand Ave., Dallas, Texas.

THE WAR WILL BE WON ON THE FARM FRONT

1943 is the crucial year on the fighting front and on the farm front. Our boys will take care of the fighting, and it is up to you, Mr. Farmer, handicapped as you are by labor shortages, to put over the farm front.

Cooperation is going to solve the labor shortage, and if you are the owner of a FOX PICK-UP CUTTER, with Corn Harvesting or Hay Harvesting Units, or both, arrange to work with your neighbors who are not fortunate enough to own one of these marvelous labor-saving devices. Help them so that they can get their Hay, Grass Silage and Corn Silage into the mow and silo.

You, as an owner of a FOX PICK-UP, will be a pivotal man in this year's farm front campaign, because you are the only one with a machine that can Harvest Hay, Grass and Corn Silage faster and with less labor than has ever been done before.

☆

This advertisement and others of similar vein, are appearing in the National farm publications to impress the farmer that a mechanized farm is the farm of today and tomorrow, that the old hand labor methods are definitely gone.

R. B. Krueger
Secretary

FOX RIVER TRACTOR COMPANY

APPLETON FOX WISCONSIN

Tennessee Section Has Meeting

ON MAY 15, at Pigeon Forge, Tennessee, fourteen members and eleven visitors of the Tennessee State Section of the American Society of Agricultural Engineers assembled in the shadow of the Great Smoky Moutain National Park for its regular semi-annual meeting. The meeting was held in modernized log cabins located on the bank of Pigeon River, that are owned and operated by a Society member, W. C. Gillham.

Hiking, horseshoe pitching, fishing, card games, and many other recreational activities were enjoyed by those in attendance, and during the meeting Mrs. G. M. Peterson made two delightful paintings of mountain scenes that would do credit to any art collection.

The men in attendance prepared and served the meals while the women complimented the delicious meals and ate enough to keep up countenance.

The technical program presented in connection with this meeting included several papers as follows: Analysis of Farm Machinery and Home Equipment Survey in Tennessee, by G. E. Martin, extension agricultural engineer for Tennessee; College Activities in Agricultural Engineering During the Wartime Emergency, by M. A. Sharp, head, agricultural engineering department, University of Tennessee; Agricultural Engineering Activities in TVA Related to the War, by C. J. Hurd, chief, agricultural engineering division, Tennessee Valley Authority; The Soil Conservation Service's Wartime Program, by W. M. Hardy, SCS; Agricultural Engineering and TVA Forestry Program, by J. H. Nicholson, TVA Forestry Division. Ira L. Knox, associate agricultural engineer of TVA, acted as leader of the general discussion on the foregoing papers. A business meeting followed the technical program.

Personals of A.S.A.E. Members

George A. Crabb, Jr., instructor in agricultural engineering, Virginia Polytechnic Institute, was recently appointed supervisor of the hydrologic research project of the Soil Conservation Service being carried on at the Virginia Agricultural Experiment Station.

J. P. Fairbank, O. C. French, and *L. W. Neubauer,* agricultural engineers, University California, are authors of a circular, entitled "A Home-Made Portable Chain Drag Elevator," which describes an elevator they have designed and built. It contains drawings and pictures illustrating a medium-sized chain drag elevator built largely of wood.

John M. Ferguson, extension agricultural engineer, Kansas State College, is author of Extension Circular 165, entitled "Home-made Field Ensilage Harvesters", recently issued.

E. N. Humphrey is chief instructor at the U. S. Army Ordnance School at the Mt. Rainier Ordnance Depot near Tacoma, Wash.

William Kalbfleisch, agricultural engineer, field husbandry division, Central Experimental Farm of Canada, has recently compiled from Canadian publications a selected bibliography on agricultural engineering and related topics. It was compiled especially for the Eastern Agricultural Engineering Committee.

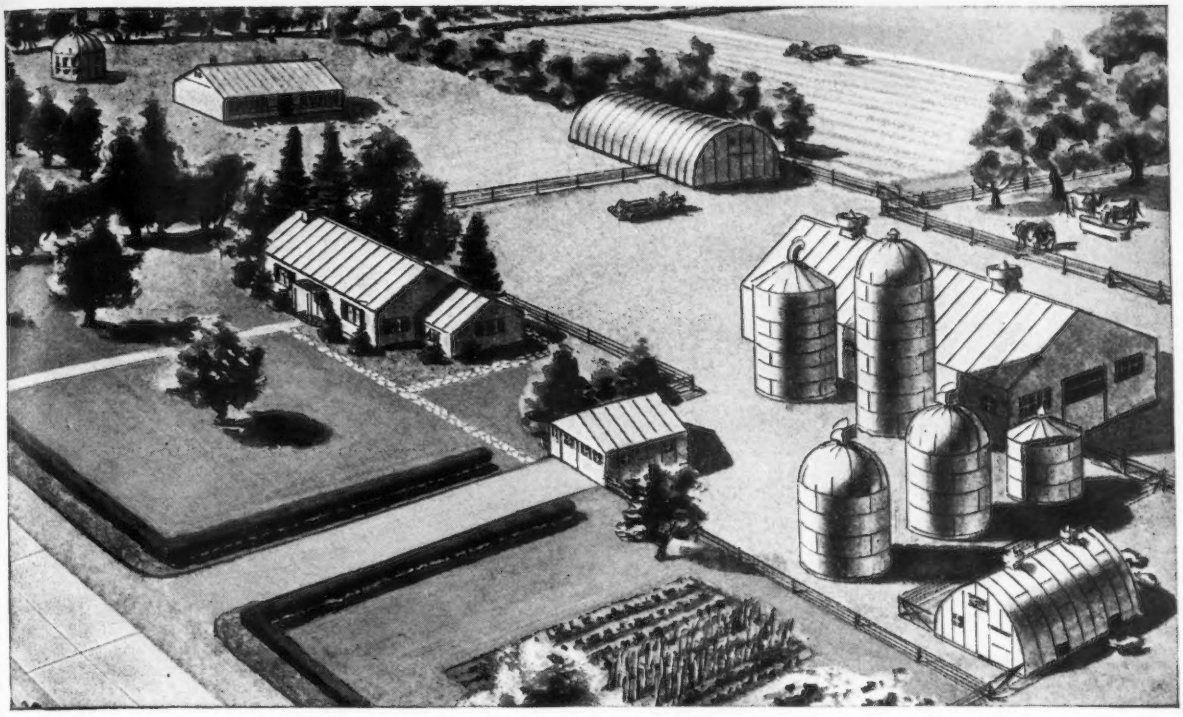
Lamar Kishlar, manager of research, Ralston Purina Co., was elected president of the American Oil Chemists Society at its recent annual meeting in New Orleans. Dr. Kishlar has been identified with research on soybean products since the pioneer days of the development of the soybean in this country, and he has also been interested in the nutritional value of cottonseed and in its processing. In addition to being a Fellow of A.S.A.E. Dr Kishlar is a councilor of the Institute of Food Technologists, and chairman of the Soybean Nutritional Research Council.

Ruby M. Loper and *F. D. Yung,* respectively, assistant extension agricultural engineer and research agricultural engineer, University of Nebraska, are joint authors of extension circular No. 729, entitled "Outdoor Electric Chick Brooder for Small Flocks," just issued by that institution.

Earl S. Patch was recently appointed sales manager of Henry L. Crowley & Co., West Orange, N. J., manufacturers of the Crolite line of steatite, high-frequency iron cores, and powder-metal parts and bearings. Formerly an executive of the Moraine Products Division of General Motors, Mr. Patch is an authority in the field of powder metallurgy with a background of research, engineering, production, and application experience which he now brings to bear on the design and fabrication problems of many industries.

Lawrence C. Porter, illuminating engineer, Nela Park Engineering Dept., General Electric Co., is author of an article, entitled "Dehydration of Foods," prepared for "The Magazine of Light," which is available in printed form. A mimeographed supplement giving a bibliography on food dehydration has also been prepared by Mr. Porter.

(Personals continued on page 210)



The farm of the future challenges your imagination

• Your opportunities for raising the standards of post-war agriculture are tremendous.

Farm buildings and equipment, as you know, can be made far more efficient. Among the modern materials you will have to draw on, ARMCO *special-purpose* sheet steels are sure to give you many useful properties and advantages. War is a great testing ground, and ARMCO mills and laboratories are learning much that will benefit your planning and designing, now and after the war.

Prefabrication should sharply lower the cost of many metal buildings. Traditional designs will be replaced by new types of buildings *engineered* to meet the health requirements of livestock and poultry for top production. Each structure will be arranged to save the farmer's time and money. Bins and cribs will be correctly ventilated and made fire-resistant and rat-proof for utmost protection.

We shall be glad to send you booklets containing useful design data on ARMCO Special-Purpose Sheet Metals . . . ARMCO Ingot Iron, PAINTGRIP, ZINCGRIP, Stainless Steel, High Tensile, Aluminized Steel and Enameling Iron. Just specify the subjects you want, mentioning your company or affiliation. The American Rolling Mill Company, 1601 Curtis Street, Middletown, Ohio.

ARMY E NAVY

THE AMERICAN ROLLING MILL COMPANY

SPECIAL PURPOSE ARMCO SHEET METALS

Extra Hands to Help the Farmer

Many concrete farm improvements are, in effect, extra farm hands on the job full time!

The experience and ingenuity of agricultural engineers can be a powerful factor in helping the farmer increase food production. While many people are pondering over relief for the farm manpower shortage, agricultural engineers are designing and applying labor saving improvements to lighten the farmer's burden.

For example, a paved barnyard on a dairy farm keeps cattle out of the mud—saves hours of time every day in grooming the cattle for milking. And a concrete dairy barn floor reduces the hours of labor necessary to maintain "Grade A" cleanliness. Then, too, stockmen and hog raisers find that concrete feeding floors help get animals to market weights faster and with less feeding.

A wide range of helpful farm improvements can be built of concrete without critical materials and with minimum use of transportation.

Our engineers will be glad to consult with you on farm building design and construction problems.

PORTLAND CEMENT ASSOCIATION
Dept. A6-1 33 W. Grand Ave., Chicago, Ill.

GIVE TO THE RED CROSS

John A. Scholten, research engineer, USDA Forest Products Laboratory, has temporarily been assigned to the Latin-American Forest Resources Project, the purpose of which in general is to investigate and appraise forest conditions in Latin-American countries, determine the quality and quantity of timber and other forest products available for the war effort, etc.; his work is related primarily to the determination of the strength, durability, and other characteristics of wood suitable for the construction of bridges, culverts, and tunnels on the Pan-American Highway.

Necrology

M. A. Raymond Kelley, agricultural engineer (BPISAE), U. S. Department of Agriculture, passed away in Washington, D. C., on May 22. Mr. Kelley was a native of Iowa, and was graduated from Iowa State College in 1912 with the degree of B. S. in mechanical engineering. He spent an additional year at Iowa State College and received a B. S. degree in agricultural engineering in 1913, and in 1922 he was awarded the professional degree of agricultural engineering from the same institution.

Following graduation, he was instructor in agricultural engineering at the University of Missouri from 1913 to 1916. In 1916 he joined the Louden Machinery Company, Fairfield, Iowa, where he was in charge of the company's plan service and technical correspondence, remaining in that position until 1918 when he was appointed an agricultural engineer in the Office of Public Roads and Rural Engineering, U. S. Department of Agriculture. He continued with the Bureau during its various reorganizations.

As a specialist in the field of farm structures, Raymond Kelley was known to the agricultural engineering profession chiefly for his research work in farm building ventilation. Raymond Kelley was one of the pioneers in farm building ventilation, and his studies in this field continued throughout his career. Aa a consequence of his devotion to this field of activity he became one of the foremost authorities on the fundamental requirements of livestock buildings.

Mr. Kelley was the author of many bulletins and professional papers dealing with his specialty, most of which appear in the publications of the U. S. Department of Agriculture and of the American Society of Agricultural Engineers.

Mr. Kelley was admitted to membership in A.S.A.E. on graduation from college in 1913 and at the time of his passing had completed an uninterrupted membership of 30 years in the organization. He was frequently a contributor to the programs at Society meetings and was active throughout his period of membership on committees dealing with various phases of farm structures.

Raymond Kelley was a hard-working, conscientious worker, and his accomplishments in the field of agricultural engineering, especially in the important branch of farm structures, will stand as a lasting tribute to his good work and devotion to the profession he loved.

Mr. Kelley is survived by his wife, Verdie Read Kelley, a sister, Jessie Mae Kelley, and a brother, James B. Kelley, professor of agricultural engineering, University of Kentucky.

Applicants for Membership

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

William L. Clark, vice president and sales manager, J. I. Case Co., Racine, Wis. (Mail) 1611 Park Ave.

Gordon A. Erickson, sales engineering dept., Wood Conversion Co., First National Bank Bldg., St. Paul, Minn.

Milton T. Hedquist, designing supervisor, J. I. Case Co., Rock Island, Ill.

Clifford M. Hill, vice-president in charge of sales, GBH-Way Homes, Inc., Walnut, Ill.

Carl D. Hullinger, eastern manager, Cuprinol, Inc., (Mail) 56 W. 45th St., New York, N. Y.

A. F. Weisgerber, fly control consultant, Detjen Corp. (Mail) 340 N. 7th St., Newark, N. J.

A. J. Whalen, supervisonr of project engineering, J. I. Case Co., Rock Island, Ill.

CHANGE OF GRADE

Joy E. Badley, president, Tractor Training Service, 610 Mead Bldg., Portland, Ore. (Associate Member to Member)

George A. Crabb, Jr., instructor in agricultural engineering, Virginia Polytechnic Institute, Blacksburg, Va. (Junior Member to Member)

Jorge H. Rodriguez-Arias, instructor in agricultural engineering, University of Puerto Rico, Mayaguez, Puerto Rico. (Junior Member to Member)

RAILROADING CROSSES A NEW FRONTIER

Today on the Great Northern, GM Diesel Locomotives *like this are hauling heavy war loads through "The Great West." On one mountain operation, consisting chiefly of movement of metal vital to victory, the utilization of GM freight locomotives resulted in an increase of 50% in train-hauling capacity.*

Here Currier and Ives, the famous portrayers of American life of the past century, depict one of the great eras of railroading—the achievement of rail transportation from East to West—the opening up of new lands and unexploited resources.

Crossing the new frontier is not alone for the railroads. GM Diesels will usher in new possibilities for the farm and for industry as well.

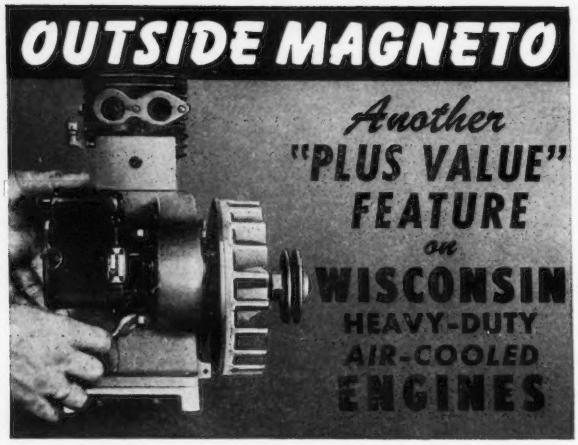
WARS have a way of ending old eras and starting new ones. Following the Peace of 1865, the nation was first united from coast to coast by bands of steel (May 10, 1869). Geographically, America has no new frontiers. Technically we have many. The curtain already has been drawn back on one element of the new era that surely will follow the present conflict —a new tool for the improvement of national transportation—General Motors locomotives.

GM
GENERAL MOTORS
DIESEL POWER

LOCOMOTIVES.....ELECTRO-MOTIVE DIVISION, La Grange, Ill.

ENGINES..150 to 2000 H.P...CLEVELAND DIESEL ENGINE DIVISION, Cleveland, Ohio

ENGINES.....15 to 250 H.P.....DETROIT DIESEL ENGINE DIVISION, Detroit, Mich.



So that there may be no lost time in starting, either with crank or rope; in any weather...

To assure positive, trouble-free ignition in operation...

To permit quick servicing if and when servicing is needed...

WISCONSIN HEAVY-DUTY AIR-COOLED ENGINES are equipped with a weather-sealed, fully accessible, *high-tension impulse-coupling outside Magneto.* A "flywheel magneto" is not good enough even for the smallest Wisconsin Engine.

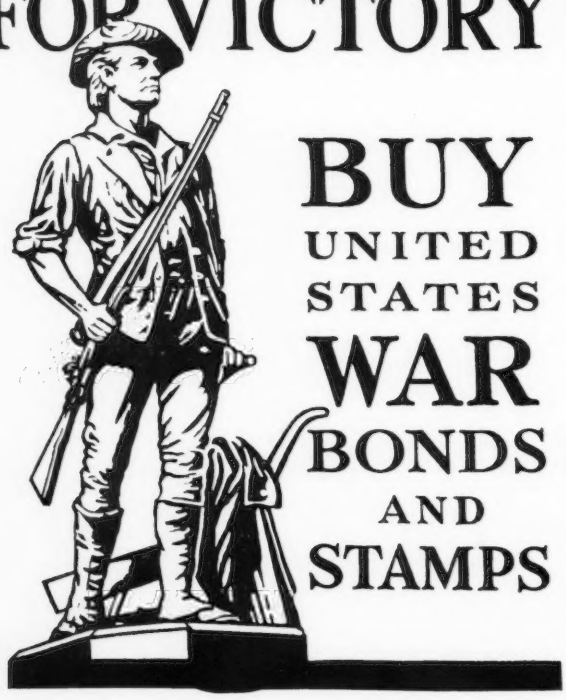
MOST POWER Per POUND

WISCONSIN MOTOR Corporation

MILWAUKEE, WISCONSIN, U. S. A.

World's Largest Builders of Heavy-Duty Air-Cooled Engines

FOR VICTORY



BUY UNITED STATES WAR BONDS AND STAMPS

This Space is a Contribution to Victory
by AGRICULTURAL ENGINEERING

Agricultural Engineering Digest

A review of current literature by R. W. TRULLINGER, assistant chief, Office of Experiment Stations, U. S. Department of Agriculture. Copies of publications reviewed may be procured only from the publishers at the addresses indicated.

PHYSICAL REACTIONS OF TILLAGE TOOLS CAUSING COMPRESSION AND ARCH FORMATIONS, AND ANALYSES OF PLOW MOLDBOARD SHAPES AND MATERIALS. Alabama Ag. Exp. Sta. (Auburn). Rpt. 1940. A new method of measuring and studying compression and arch action development by F. A. Kummer.

UNDERGROUND LEAKAGE FROM ARTESIAN WELLS IN THE LAS VEGAS AREA, NEVADA, *P. Livingston.* U. S. Geol. Survey (Washington), Water-Supply Paper 849-D (1941). From observations in 42 wells explored with a current meter designed for measuring the flow at various points in deep wells, it is concluded that the aggregate leakage from wells is not great enough to be responsible for more than a small part of the serious decline in water levels and artesian pressure in the basin. Great quantities of water are allowed to flow from the wells without being used beneficially or economically, however. It is believed that if the draft on the artesian basin were reduced and strict measures of conservation were applied, the pressure would increase noticeably, especially in the shallower sands.

AGRICULTURAL ENGINEERING INVESTIGATIONS. Colorado Ag. Exp. Sta. (Fort Collins) Rpt., 1941. Snow surveys (coop. USDA et al) are noted; also, experiments with high-strength wire for reinforcing precast concrete beams, in which adequate reinforcement was provided by about one-half as much steel as is required in conventional design; waterproofing of adobe construction; experimental check of Rohwer evaporation formula; meteorological observations; photographic method of making snow surveys; pumping for irrigation and drainage; apparatus for measuring fall velocity of particles in water; separation of sand according to fall velocity in water; design and invention of irrigation structures and apparatus; irrigation use of ground water in the South Platte drainage basin; fluctuation of ground-water levels; and sugar beet machinery work, including single-seed planters, experiments on mechanical thinning, and a variable depth planter.

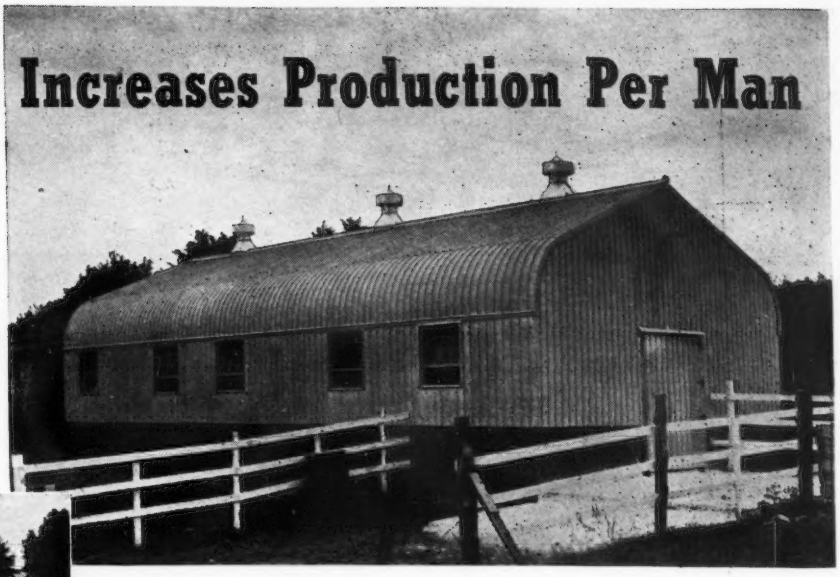
STRENGTH PROPERTIES OF CHINESE ELM GROWN IN MICHIGAN, *A. J. Panshin.* Michigan Ag. Exp. Sta. (East Lansing) Quart. Bul., 24 (1941), No. 2. Chinese elm wood *(Ulmus pumila)* has a specific gravity of about 0.5, based on oven-dry weight and volume. The sapwood is light yellow, while the heartwood ranges from brown to dark brown, with a reddish tinge. The wood when planed has a good figure caused by the alternate bands of the open-textured, lighter-colored springwood and the close-textured, darker summerwood.

Testing machine data indicate that the fast-grown wood of Chinese elm is inferior in modulus of elasticity to the wood of average strength of the three American species of elm. It is comparable to American elm *(U. americana)* in modulus of rupture and in sheer parallel to the grain, but is inferior in this respect to slippery elm *(U. fulva)* and to rock elm *(U. thomasi)*. In compression parallel to the grain, the samples of Chinese elm tested were superior to American elm, comparable to slippery elm and inferior only to rock elm. In hardness, both on end and side grain, Chinese elm was excelled only by the rock elm. On the basis of strength, fast-grown Chinese elm may be considered equal to American and slippery elms except in static bending, in which it has a considerably lower modulus of elasticity.

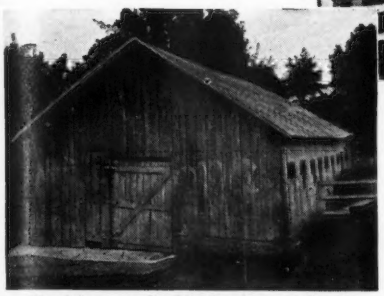
GEOLOGY AND GROUND-WATER RESOURCES OF THE BALMORHEA AREA, WESTERN TEXAS, *W. N. White, H. S. Gale, and S. S. Nye.* U. S. Geol. Survey, (Washington), Water-Supply Paper 849-C (1941), The lands are irrigated with water derived chiefly from large springs but partly from the storm flow of Toyak Creek. The storm flow and a part of the winter flow of the springs is stored in a reservoir. The combined discharge of the springs during dry years is about 23,000 gpm, of which amount the artesian springs supply more than 90 per cent. The geology of the water-bearing formations is discussed as are also the intake and discharge of ground water.

EXPERIENCES IN OPERATING A CHEMICAL-MECHANICAL SEWAGE TREATMENT PLANT, *G. J. Schroepfer.* Amer. Soc. Civ. Engin. (New York) Proc., 67 (1941) The author presents data concerning the performance of the plant and the cost of operation and maintenance, as well as on the improvement of the Mississippi River which hase resulted from its first 2 years of operation. Some of the problems that arose in early operation, the methods used to overcome them, and other improvements and changes which have been incorporated to simplify operation or effect economies are discussed. *(Continued on page214)*

Jamesway Increases Production Per Man



This Jamesway Iron Clad replaced the old barn shown below and represents an investment of about the same sum as a good wooden barn would have cost. Mr. Riggins and his son Bryant checked carefully with Jamesway users, also checked cost estimates accurately. In every way, the Jamesway proved to be best for the herd and for the men who care for the cows.

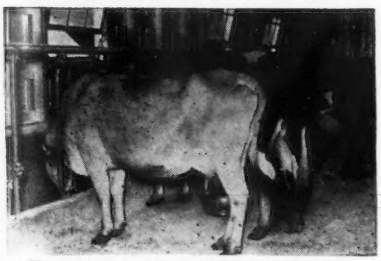


Wood barn on the Riggins farm, replaced by Iron Clad Jamesway, shown to the right.

This 20-Stall Jamesway Iron Clad Will be up-to-date 20 Years from Now

For just about the same money he had planned to invest in a good wooden barn, B. F. Riggins, Jr., Arlington, Tenn., has this 20-stall-and-feed-room Jamesway Iron Clad that will be up-to-date 20 years from now. Its heavy zinc coating will probably never know need for paint. Flying sparks won't ignite it. It will stand plumb and true throughout the years and provide the utmost in sanitation.

Fresh air is provided by Jamesway Ventilators. Jamesway metal windows assure easy opening and closing and freedom from maintenance cost. Increased milk production soon repays the investment in Jamesway buildings and time-saving barn equipment.



Clean, airy conditions for milk production with Jamesway Roof Ventilators and Metal Windows. Jamesway Steel Stalls are set in high cement curb. Floors are flushed after each milking.

Go JAMESWAY ALL THE WAY .. PLAN NOW

•• OVER 50,000 FARMS ARE SERVED BY JAMESWAY EACH YEAR

"What Should I Buy First?"

Help your farmers make sure that the things they buy will bring fullest returns in increasing ability to produce more per man. Measure values of improvements by asking: 1. How many days would I use it; 2. How much would it increase production; 3. How much time would it save; 4. How soon will it earn its cost? Jamesway Barns and Equipment "measure up" on all four points.

Help your farmers save now with War Bonds for modern farm buildings that make for healthier livestock and poultry—more milk, eggs and meat—more convenience for themselves—greater protection from fire hazards. Start planning today with Jamesway. See your nearest Jamesway man or Dealer or write

JAMES MFG. CO., Dept. A-643

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EQUIPMENT & HOUSING

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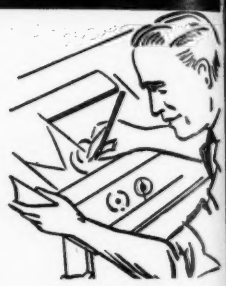
MORE MILK-EGGS MEAT

IF YOU USE

WHEELS or AXLES

YOU NEED OUR ENGINEERING EXPERIENCE!

WE HAVE cooperated closely with Industry for more than 50 years — producing millions of dependable, efficient steel wheels and axles; each specifically suited to its task. The knowledge gained through all this experience is available to you NOW — to help you get the utmost service and satisfaction from YOUR "rolling stock." Write today for complete Illustrated Bulletins.



EWC WHEELS

ELECTRIC WHEEL CO., Dept. AE, Quincy, Ill.

Agricultural Engineering Digest

(Continued from page 212)

SOME SOIL CHANGES RESULTING FROM DRAINAGE, *H. B. Roe.* Soil Sci. Soc. Amer. Pro., 4 (1939); abs. in Minnesota Ag. Exp. Sta. (St. Paul) Rpt. 1941. Studies of open-ditch drainage effects on Minnesota swamp forests show large reductions of harmful acidity and much stimulation of desirable bacterial action and of timber growth during the life of the trees. Good permeability was shown to be developed, through from 13 to 20 years of tile drainage, in originally tight silt and clay loam and marl soils in Minnesota and North Dakota. Total subsidence of cultivated peat in Minnesota is shown to be closely proportional to depth of drainage on an experimental tract on which the water level was controlled at various successive depths.

A GRAPHICAL SOLUTION OF HEATING PROBLEMS, *R. M. Johnson.* Va. Engin. Exp. Sta. (Blacksburg) Bul. 45 (1940). The author reduces heat loss through net area of given wall construction to a logarithmic equation of the form plotting as a straight line on a logarithmically ruled graph, gives six examples of the use of this method, and provides tabulated data for the application of the method to walls of many common types.

RADIATOR CAPACITIES IN TERMS OF HEATING LOADS, *J. L. Dilworth.* Va. Engin. Exp. Sta. (Blacksburg) Bul. 45 (1940). The author points out the fictitious character of the equivalent direct radiation unit and the ambiguity of equipment ratings expressed in terms of such a unit. He presents a graph, two straight lines for the conversion of the heat loss (in thousands of Btu per hr) into square feet of equivalent direct radiation either of water or of steam, respectively.

AGRICULTURAL ENGINEERING INVESTIGATIONS OF THE BUREAU OF AGRICULTURAL CHEMISTRY AND ENGINEERING. U. S. Dept. Agr. (Washington) Bur. Agr. Chem. and Engin. Rpt., 1941. The topics reported upon are farmhouse research; buildings for livestock; silage-pressure studies; potato, corn, wheat, and grain-sorghum storage; pest-control equipment; fertilizer-distributing and crop-production machinery; ginning and packing cotton; fiber-flax processing; and uses for electricity in farming.

WATCH YOUR STEP: FARM SAFETY FOR NATIONAL DEFENSE, *W. Brink.* U. S. Dept. Agr. (Washington) Misc. Pub. 481 (1942). Possible causes of accident or injury likely to be found in buildings, farm machines, electrical equipment, gasoline and other inflammable materials, home appliances, and farm animals are pointed out in some detail. Causes of fires, fire prevention, and provision of adequate fire-fighting facilities are among the subjects especially stressed, as are numerous causes of minor and major personal injuries. Preventive or protective measures are suggested wherever practicable. Figures showing agriculture to be the most hazardous occupation are graphically presented.

Bread and Circuses

(Continued from page 182)

political courage than to appease certain pampered pressure groups, but it is better economics than to furnish food at fictitious prices, pay the deficit from the treasury, and finance the finagling by floating bond issues to banks and insurance companies.

It is time to stop thinking that we can eat our cake and have it, too. It is futile to foster the notion that all classes or any class, can go along in a war without paying for it, that wages for labor or prices to farmers can or should be pushed up enough to preserve peacetime standards of living and luxury. If equality of sacrifice is to be anything but an oratorical phrase, the people who work for wages or for prices per bushel must take, and take willingly, the same lowering in the level of living as do those who subsist on salaries or on the return from savings.

The more honestly we face our problems and the more equitably we accept our deprivations, the better will be the chance for our profession, and for all whose technical skills promote production and reduce costs, to mitigate the severity of sacrifice for the whole people.